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POWER

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POWER

NEW YORK, JUNE 6, 1911

PROBABLY few engineers realize the influence that the mental attitude has upon their conditions and surroundings. It is said that shortly before Jeffries met Johnson in the ring he remarked that he wished it was over.

He went into the contest with a fear in his heart that dimmed his eye and depressed his spirit. His body, under the control of an unsound mind, was infirm and unstable, and his ineffective blows and spiritless tactics brought on certain defeat.

After seeing that there was a wide variation between the reading of the steam gage and the blowing point of a new safety valve, an engineer wished for the old valve back on the boiler.

Fear of something he only partially understood impaired his judgment and he went wrong. He trusted the steam gage, screwed down on the valve-spring nut and burst the boiler with over pressure.

While it matters little which of two pugilists has the heavier punch or can stand the more severe punishment, the lesson, by the result of the mental attitude of men at critical moments, is rich in the possibilities of its teachings.

Johnson knew and had the confidence that knowledge begets. Jeffries did not know. To him the result was a matter of doubt and he failed; not because of inferior physique and agility, but because doubt and fear lodged where only knowledge and confidence should rest.

Doubt and ignorance led the engineer to tamper with the safety valve when knowledge, and confidence in that knowledge, would have prevented a disastrous explosion which snuffed out more than a score of lives and destroyed thousands of dollars worth of property.

Knowledge is power, and the man who knows, knows that he knows, and his decisions are born of the confidence based on that knowledge.

To the engineer who knows his vocation and his plant, what it will do and what it will cost to operate it under the varying demands of the service, has no fear that the central-station wires will furnish the energy that makes the wheels go around in his plant.

It is the man who does not know who fears this competition and the one who will get the "wallop" in the first round, while he who knows and shows that he knows, will win "hands down" both as an engineer and as a man.

A Really Low-Pressure Turbine

By Henry F. Schmidt

A turbine designed to operate between an admission pressure of 2 1-2 pounds absolute and an exhaust pressure of 1 pound absolute. On a test this machine showed a Rankine efficiency of 52 per cent.

Much has been written about low-pressure turbines, that is, turbines taking steam at a pressure equal to or lower than that of the atmosphere, and also of the great increase in economy gained by the use of a high vacuum on high-pressure condensing turbines. Attempts have been made to show by diagrams that the amount of energy available in a pound of steam expanded from atmospheric pressure to a 29-inch vacuum is approximately equal to the energy available by expanding from a pressure

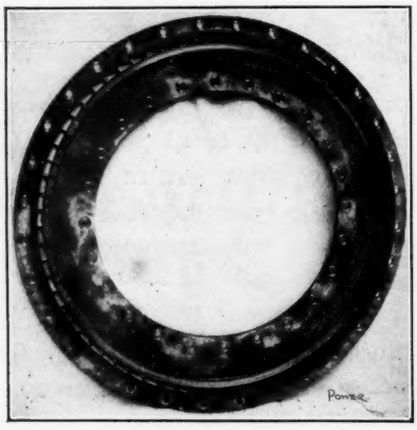


FIG. 1. NOZZLE BLOCK

of 150 pounds absolute to atmospheric pressure. Likewise, the statement has been made repeatedly that a large proportion of this available energy is lost in the low-pressure cylinder of a reciprocating engine because release occurs before complete expansion has taken place.

So far, however, it has been necessary to trust almost wholly to theory, and for the benefit of those who are not yet convinced of the soundness of the theory, some tests and details are presented of a turbine designed to develop 20 brake horsepower when supplied with steam at 2½ pounds absolute pressure and exhausting into a condenser maintaining a pressure of one pound absolute.

This turbine is of the impulse type, having all the energy available in the steam converted into kinetic form in the nozzles. There are two "velocity drops"; that is, the steam first traverses one row of moving blades and then enters reversing chambers where it is redirected into a second row of moving blades without a drop of pressure.

As shown in the view of the nozzle block, Fig. 1, the turbine is of the total-admission type; that is, it takes steam around the entire circumference. The steam after leaving the nozzles enters the inner row of blades of the rotating wheel, shown in Fig. 2, and after having passed through the inner row enters the inner row of passages of the reversing chamber shown in Fig. 3. The steam passes through the reversing chamber and leaves it at the outer openings, reëntering the rotor and passing through the outer row

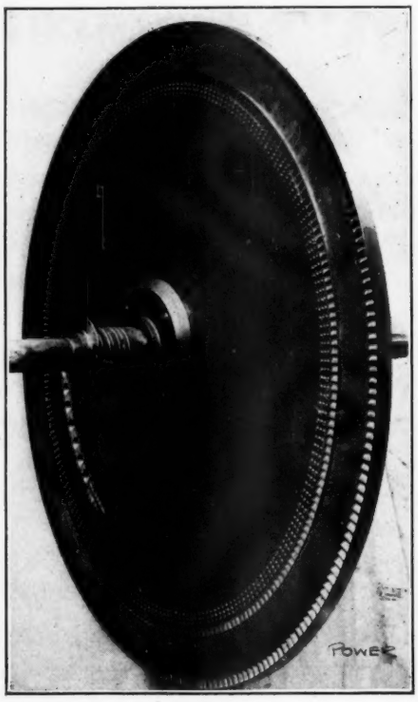


FIG. 2. WHEEL DISK

of blades, after which it passes to the condenser. This path of the steam can be understood better by reference to the cross-section in Fig. 4, in which *A* is the steam inlet; *B* is the steam chest extending completely around the turbine; *C* is one of the nozzles; *D* the inner row of blades; *E* the reversing passage; *F* the outer row of blades and *G* the exhaust ports. Two exhaust ports were provided, as this was an experimental machine, and it was desired to note the effect of taking steam away at different points. The nozzle block, shown in Fig. 1, is represented by *H* in Fig. 4, and *I* is the reversing chamber, shown in Fig. 3.

CONSTRUCTION

The bearings are of the standard babbitted type with ring oilers, and the glands, to prevent the leakage of air into the cylinder, are of the snap-ring type and water sealed. Water guards *J J* are fitted to prevent any water escaping from the glands and getting into the oil.

Fig. 2 shows clearly the way in which the blades are attached to the disk. A groove is turned in the disk and the shank of the blades inserted, the latter being secured in place by three Stubb's steel pins driven in and riveted over. This has proved a very satisfactory fastening, and is easily made and very strong, as is shown by the fact that this turbine was run at blade speeds in excess of 600 feet per second without any ill effects, in spite of the fact that the blades are unusually heavy. Furthermore, the construction readily permits the replacement of blades which may become damaged, only a few minutes being required to replace a blade.

A point in design which may be criticized is the fact that the turbine is not split horizontally, which fact makes assembling difficult, as it requires uncoupling and drawing off the turbine half of the coupling before the rotor can be removed. The reason for employing this rather undesirable type of construction was because splitting the turbine along the horizontal joint would have involved a rather complicated construction to in-

FIG. 3. REVERSING CHAMBER

sure steam and air tightness—which, in this case, is of the utmost importance. It will be noted that there is but one joint which can leak air into the exhaust chamber, and as these surfaces are bored and turned, a tight joint was easily obtained.

The side clearances are approximately 1/16 inch and the radial clearances are

very large. As a matter of fact, the longitudinal clearances are far greater than they should have been, as 10/1000 is ample clearance in a turbine of this capacity, and smaller clearances would have shown better economies than were obtained.

As there was no governor designed for this turbine, an automatic stop valve was fitted, which consisted of the usual overspeed tripping device and a 2-inch vacuum breaker, which, as the inlet pressure to the turbine was always below atmospheric pressure, would shut down the turbine before it could reach a dangerous speed.

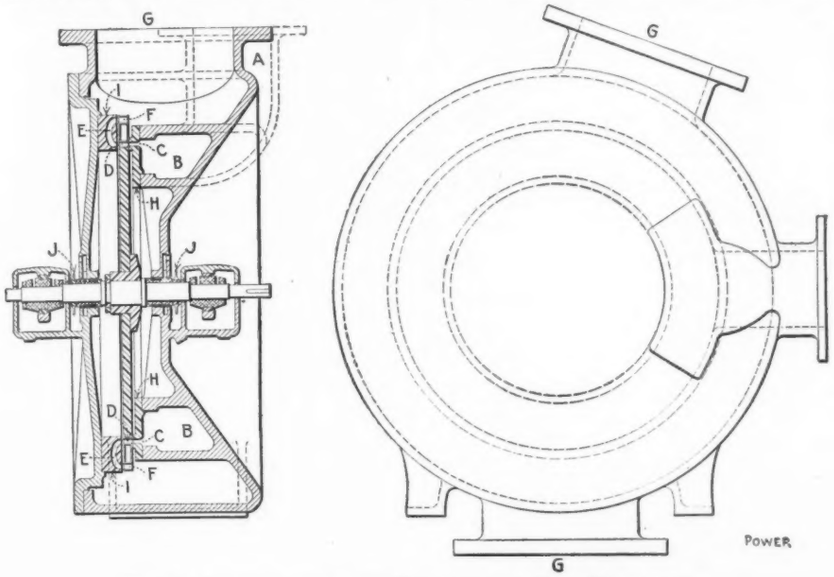


FIG. 4. SECTION THROUGH TURBINE AND END ELEVATION

TEST ARRANGEMENTS

As shown in Fig. 5, which represents the turbine ready for testing, the power developed was absorbed by a small water brake *D*. The load on the brake was measured on calibrated platform scales and water was supplied through the pipes *H H*, fitted with valves to control the brake resistance.

The inlet pressure was measured by the mercury column *B* and the steam temperature by means of the thermometer *C*, which was graduated to read to one-half a degree. The vacuum in the turbine exhaust was measured by the mercury column *A*, and the variation of speed between observations with a speed counter was observed by means of a tachometer. As it was necessary to throttle the steam supply from 150 pounds to a 25-inch vacuum, a water jet was fed into the steam line in front of the throttle to keep the steam saturated and prevent the superheating which the wiredrawing would otherwise have caused.

The steam was condensed in a surface condenser and the water weighed in tanks on platform scales, the weight being checked every five minutes.

The turbine glands were supplied with water from a barrel by the pump *G*, which delivered it to the pipe *E*. In order to maintain a constant water pressure in the glands, an overflow pipe *I* was fitted and drained any excess water back into the supply barrel.

As the glands were not perfectly tight, all the leakage to the outside was caught and returned to the barrel by the pipe *F*. By this arrangement no gland water was lost outside of the turbine, as all the water which was necessary to maintain the original level in the supply barrel must have passed into the condenser where it was weighed with the condensed steam and was, therefore, subtracted from the condensation. The supply barrel was fed from another barrel above it mounted on platform scales.

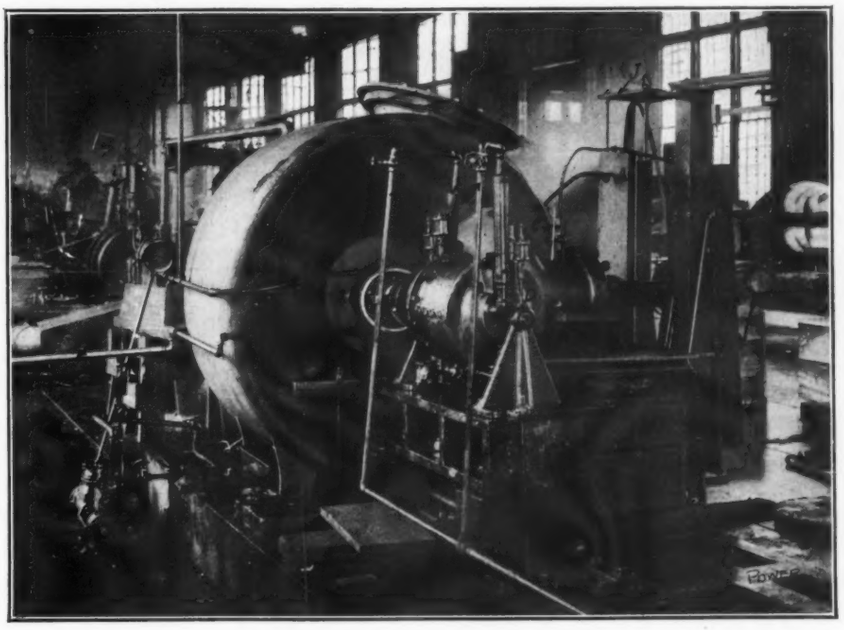


FIG. 5. TURBINE RIGGED FOR TESTING

RESULTS OF TEST

Although the turbine was designed to operate between 2½ pounds absolute and one pound absolute, the tests were carried over a considerable range, and the power developed varied from friction load to nearly 500 horsepower. One of the most astonishing results was the operation at friction load, 2250 revolutions per minute being attained with a pressure difference of ¼ inch of mercury between the steam inlet and the exhaust, and 1400 revolutions per minute with a difference in pressure less than 1/10 inch of mercury, measured by a U-tube connected between the inlet and exhaust chambers. The latter was with nearly a 29-inch vacuum in the exhaust, but even at that low pressure 1/10 inch of mercury pressure difference theoretically gives up only about 4 B.t.u. per pound of steam, corresponding to a steam velocity of about 448 feet per second.

In Figs. 6 and 7 the horsepower, total water per hour and water rates have been plotted against the absolute inlet pressure. If all the test observations are correct, the curves of horsepower and total water per hour should be straight lines, as each varies as a straight-line function of the absolute inlet pressure. The closeness with which the actual test points fall upon a straight line shows the accuracy of these tests, as all the points shown are taken from the actual tests without any corrections of any sort whatever.

In Fig. 6 are shown the results with various inlet pressures up to 4.9 pounds absolute and with a vacuum of approximately 28¼ inches referred to a 30-inch barometer. As will be noted from the water-rate curve, at 2½ pounds absolute

the turbine consumed but 69 pounds of steam per brake horsepower, or 56 pounds less than the guarantee of 125 pounds per brake horsepower.

The curve marked "efficiency" is for the Rankine cycle, or the ratio of the brake horsepower developed to that theoretically available for the given inlet and exhaust pressures. Also the B.t.u. theoretically available has been plotted against the absolute inlet pressures.

The efficiency curve first rises and reaches a maximum at about the inlet pressure for which the turbine was designed, and then gradually decreases. The reason for the increase in efficiency at first is due to the friction load becoming a smaller proportion of the total power developed, and the decrease in efficiency beyond 3 pounds absolute is due to the fact that the nozzles were designed only for the pressure range of 2½ to 1 pound absolute, and have not sufficient divergence to efficiently handle the higher pressure ranges. This will be further observed from the tests shown in Fig. 7 with 26- and 27-inch vacuums. In these tests the point of maximum efficiency has shifted to higher inlet pressures, but occurs at approximately the same B.t.u. range as during the tests at 28¼-inch vacuum.

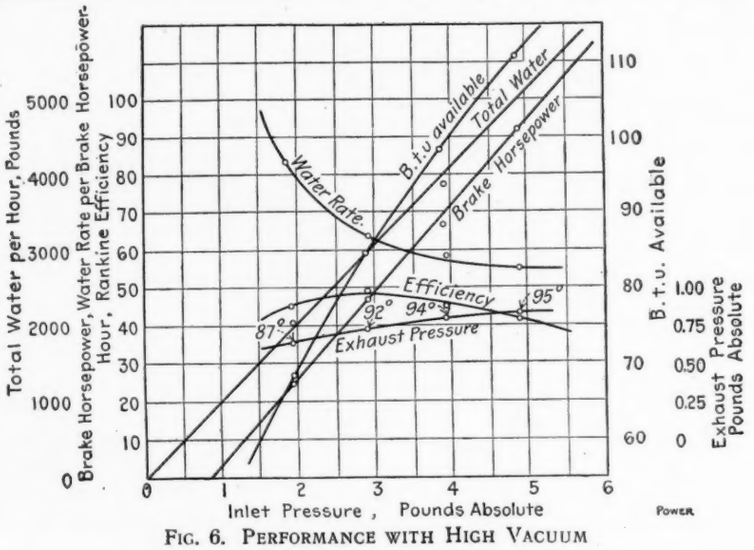


FIG. 6. PERFORMANCE WITH HIGH VACUUM

CONCLUSIONS

There are several points of interest shown by these tests which, though they have been known in a general way, have never before, to the writer's knowledge, been proved in the same conclusive manner as by the tests on this small turbine.

Looking at the test results the reader should not confine himself to the water rates per brake horsepower-hour, but should observe rather the Rankine efficiency, which, after all, is the only true criterion. Low water rates can easily be obtained even with a poor machine, if the operating conditions are made favorable. The actual measure of the value of a machine, however, is not its output but the proportion of the output to the maximum obtainable.

The maximum Rankine efficiency obtained was 52 per cent., and varied from this figure down to as low as 42 per cent. under extreme operating conditions. In tests on a number of high-pressure noncondensing turbines of exactly similar design and under varying conditions, the highest Rankine cycle efficiency ever obtained was 48 per cent. This shows that steam expanded at even the lowest pressures can be utilized in a steam turbine not only as efficiently but more efficiently than high-pressure steam.

However, the writer does not wish to be understood to have made the statement that in every case low-pressure steam is as efficient or nearly as efficient as steam at a moderate pressure, for there are conditions which arise where for practical purposes it is impossible to establish those necessary points in design to accomplish the best results. The tests do prove, however, that any degree of efficiency which can be obtained with high-pressure steam cannot only be duplicated with low-pressure steam but can be exceeded. Hence, it is only fair to say that while the turbine tested was not of a high efficiency, turbines of the Parsons or reaction type can be built, which over the same range would develop a Rankine efficiency of 75 per cent., or better.

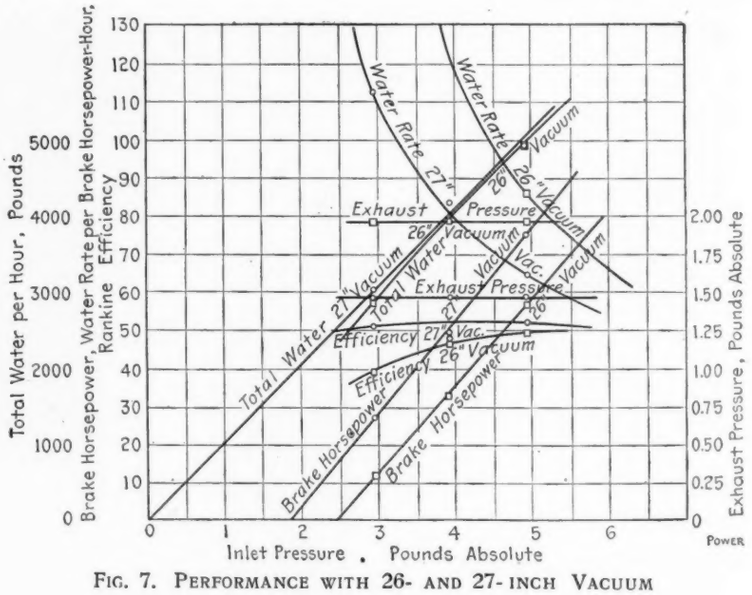


FIG. 7. PERFORMANCE WITH 26- AND 27-INCH VACUUM

A Lentz Engine on the Pacific Coast

Due to the construction of an annex for the Hotel Alexandria, the leading hotel of Los Angeles, Cal., extensive additions are being made to the power plant thereof. The plant will contain six Stirling boilers of 1100 horsepower total rated capacity. Provision will be made for 700 additional boiler horsepower.

The present electrical generating equipment consists of one 150- and one 250-kilowatt Bullock dynamos, each driven by a Skinner compound automatic engine. To this will be added one 300-kilowatt Fort Wayne dynamo to be driven by a Lentz type poppet-valve engine built by the Erie City Iron Works. This is the first engine of its type to be installed in this country west of Chicago.

The refrigerating plant will remain unaltered. There are a Stevens compressor of 20 tons capacity, driven by an electric motor, and a Vulcan Iron Works compressor of 55 tons capacity, driven by a steam engine.

The hotel is equipped with hydraulic elevators which are operated by a 5,000,000-gallon Monarch pumping engine built by the H. N. Strait Company.

A complete description of this interesting plant will be published as soon as possible after the finishing touches have been made.

The Value of Flue Gas Analysis*

By Joseph W. Hays

How the fireman can be interested in the subject of combustion and flue-gas analysis without resorting to any chemical terms, whatever. The disadvantage of too much air is shown and hints are given as to taking samples.

*From a paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers, at Youngstown, Ohio, May 18, 1911.

Fuel is the largest single item of expense in almost every steam-power plant. The fuel is often purchased without reference to or a check upon its potential heat value, and is burned, almost invariably, with an utter disregard for economy. The fireman is provided with a shovel and allowed to have his own way with the coal pile. If he can throw coal straight enough for it to pass through the door and keep up steam, he is a good fellow. No attempt is made to instruct him. No check is kept upon him. He shovels coal in the same way that he is permitted to worship in this country, "according to the dictates of his conscience," and as a result wastes from 20 to 60 cents every time he puts a dollar's worth of coal in the furnace.

In order to insure the highest possible furnace efficiency it is necessary that the engineer or some other responsible person should first ascertain the correct method of furnace operation. No rules can be laid down that will apply to all plants except in a general way. Every plant and, to a certain extent, every boiler, is a problem in itself. The engineer, before he undertakes to instruct the fireman, must see to it that the boiler settings are tight and the dampers in order. He must learn what draft should be employed for the best results, how thick the fires should be carried and various other things of importance.

When the engineer knows his boiler furnaces and exactly how they should be managed to secure the best economy, the next step is to make sure that the fireman will follow instructions. This is where the real difficulty comes in, but the problem is an easy one if it is approached from the right direction.

The fireman should have explained to him what the engineer is striving to accomplish; he must be shown how the furnaces should be operated and what arrangements have been made to keep a check upon him. Say to him: "Do this and do that and you will get all of the steam possible out of every pound of fuel. If you do not operate the furnaces according to these instructions, we shall know it, and we intend to find out who the best firemen are in this boiler house."

The fireman will exert himself to secure results when he knows there is a continuous and reliable check upon him. His efforts will be redoubled when he discovers that he is in competition with every other operative in the furnace room; that it is a free-for-all race to discover who is the best man. This is only natural, and the man who says that he cannot handle firemen admits that he does not understand human nature. Place the thing upon the basis of a sporting proposition and the firemen will do the rest.

The average engineer is frightened when the subject of engineering chemistry is suggested. He has never studied the science. He is too old and perhaps lacks the education necessary to tackle it. Chemistry is impossible so far as he is concerned; therefore, how can he expect to apply the science in his boiler house and reap some of the economies he has been reading about? The chemistry that the engineer ought to know, however, involves very little special knowledge. The most ordinary fireman can understand all that any practical man need know about it.

Suppose "Mike" is just an ordinary, everyday fireman; CO_2 could not be beaten into him in a thousand years, but he can be filled with chemistry without reference to a chemical formula. He is discovered in the act of throwing coal into the boiler furnace, and it will be noticed that he is careful to close the furnace door when he is through firing. Say to him: "'Mike,' why do you close the door when you are through throwing in the fuel? Why not leave it open? Why not take the door off and throw it on the scrap pile? Every time you close the door you have to open it again. This takes time and means work and might burn your fingers."

"Mike" is astonished and proceeds to deliver a lecture on economical furnace operation. He says: "Do you see that steam gage up there? Well, it is my business to keep the arrow pointing at 100 pounds. How long do you think I could hold steam if I left the fire door open? The cold air would rush in and cool off the boiler." Thus he gives, offhand, the greatest of all causes of fuel waste—excess air. When asked if it makes any difference where the excess air enters, he cannot see that it does, and his attention is called to a bare spot a foot and a half square over in the southwest corner. He is shown cracks in the fuel bed where the coal has coked and broken open in fissures. These bare places and cracks are letting fully as much air into the furnace as could possibly pass through the open fire door. Then the engineer in charge is called. He is asked if the boiler settings are tight and free from leaks. He is quite sure that they are. A candle is procured and it is found that the setting is leaking like a sieve; that there are a hundred openings big and little where the flame is drawn in. The suction at some of these holes is strong enough to snuff out the candle. The plates about the blowholes and clean-out doors are loose. In many places it is possible to insert the fingers. If it be a return-tubular boiler, a hole of several inches area may be found around the blowoff pipe; if it be a water-tube boiler, air leaks about the headers.

How much attention do the dampers get in the average plant? Is there any pretense whatever to any kind of damper regulation? There are steam boilers that are not equipped with dampers at all. Not one steam plant in five will shift its dampers a hair's breadth during the entire day's run. Not one steam plant in fifty is supplied with a proper draft gage. Not one plant in a hundred that has such a gage makes a proper use of it. Managers and owners are always complaining about the coal consumption. It is too high. They wonder where the trouble is located.

The boiler damper stands in the same relation to the furnace that the cutoff valve occupies to the engine. The one is intended to adjust the rate of coal consumption to the steam demands upon the boiler, the other to suit the rate of steam consumption to the power demands upon the engine. If steam is wasted at the engine, the money loss is not measured by the wasted steam but by the coal that was burned to generate this steam. It is a question of fuel loss, first, last and always.

In every properly designed power plant an excess of draft is provided for, in order that there may be sufficient coal-burning capacity to take care of all future loads and all probable increase in the power demands.

Excess air will do more to lower efficiency than any other known agency. Such excess should not exceed 40 per cent., but as the average plant is operated it is found in the neighborhood of 250 per cent. Enough air flows through the furnace of the average boiler to keep nearly three such boilers going under the conditions of good furnace practice. The preventable waste occasioned by such excess air is about 15 per cent. of the fuel.

When the air supply is insufficient, combustion will be incomplete and the waste due to this cause may run as high

as 15 per cent. of the fuel. Most steam plants suffer from both excess air and incomplete combustion. The losses due to the first mentioned cause, however, are usually about 10 times those due to the latter.

When the draft pressure is increased the time allowed the air to work its way through the fuel bed and act upon the coal is decreased. Excess air accordingly finds its way into the furnace chamber. If the fuel bed is thin, the volume of such air excess is multiplied, and if there are cracks or "rat holes" in the fire there is another multiplication. When the draft is increased the suction is multiplied at every crack and fissure leading into the furnace and the gas passages of the boiler.

Increased draft usually means an increase in the temperature of the escaping gases. It also means an increase in the volume of the gases flowing up the chimney in a unit interval of time. When the gases are diluted and the dilution is followed by raising the temperature of the escaping mixture, there is employed the most effective method that has ever been discovered to increase the coal bills.

If coal is to be burned economically, the draft must be maintained in proper relation to the load and to the fuel in the furnace. If the dampers are manually operated, only an approximation can be expected of correct draft conditions, because, to have correct draft continuously, the damper must be kept continuously on the move in order to compensate for the several variables referred to.

There are a number of good damper regulators on the market, but there are also a great many poor ones, and a poor regulator may be worse than no machine at all. Automatic damper regulators may be divided into two classes for the purposes of this discussion: First, the machines that swing the damper from the wide-open position to the closed one when the pressure rises, and back again from the closed position to the wide-open one when the pressure falls; second, the machines that maintain the damper in such intermediate positions as the varying conditions of load may call for.

Machines of the first class may produce a perfect steam line on the gage chart, but they may and often do obtain uniform pressure at the expense of economy; whereas, machines of the second class will secure economy, and uniform pressure will follow in the wake of economy.

Regulators of the first class operate the dampers as follows: Assume the machine to be adjusted to hold the pressure at an even 100 pounds. The pressure rises slightly above this point and the machine immediately closes the damper and shuts off the draft. Combustion is interfered with because the furnace is now receiving insufficient air, and the pressure falls. This would be well enough were it not for the fact that insufficient air means incomplete combustion and a loss of 10,000 B.t.u. for every pound of carbon converted to CO. If, on the other hand, the pressure should fall below 100 pounds, the damper is thrown wide open. The furnace gets practically no air at all when the damper is closed and all the air that the chimney can pull through it when the damper is open. The machine provides the furnace one minute with a feast of air and the next minute with a famine.

Regulators of the second class keep the damper continuously on the move, shifting its position in one direction or the other with every little variation of steam pressure.

There is one particular in which practically all damper regulators fail, by reason of the fact that the machines, whether they come under the first or the second classification, are governed by the steam pressure. When the fireman opens the fire door, cold air enters, chilling the furnace and the boiler, and causing the pressure to fall. This blast of cold air reduces the furnace temperature, and the temperature drops all along the line between the furnace door and the top of the chimney. When the door is closed the temperature rises again rapidly. This means expansion and contraction, which is bad for both the boiler and the setting, causing cracks in the brickwork and leaks in the boiler. It also means a loss of fuel, because coal must be burned to restore the furnace again to its normal temperature.

When the furnace doors are opened the damper should be closed. Damper regulators usually do the wrong thing under such circumstances; they throw the damper wide open. They do this because they are governed by the steam pressure.

There are four ways in which the furnace and the fireman can waste coal:

1. A large portion of the heat energy generated may be nullified by excess air. Combustion may be complete to the last atom of the combustible, and yet, if the gases are cooled off as fast as manufactured they will be of little use to the boiler.

2. Combustion may be incomplete. In such cases a portion of the fuel passes up the furnace in an unconverted condition. Smoke usually accompanies incomplete combustion. but not necessarily and not always. There may be a great deal of smoke and very little combustible matter in the gases or there may be no smoke at all and a great deal of combustible.

3. Much fuel may be, and some fuel always is, lost with the ash and clinker. These losses are often the fault of the grate.

4. More or less heat will be radiated from the furnace and some loss of this kind is unavoidable. The only remedy is insulation so far as it can be applied to the furnace and boiler setting.

No one can look at a furnace and say exactly how near to or how far from the highest attainable economy it may be performing. With a flue-gas analysis instrument the efficiency of the furnace can at once be determined, and if coal is being wasted the cause of the loss is ascertained and steps may be taken to correct it. No other apparatus can be substituted for the gas-analysis instrument in this sort of an investigation, because nothing can be said about furnace efficiency until all is known about the quality of the escaping gases; it is these gases alone that can tell the percentage of excess air being heated and the proportion of combustible matter discarded to the chimney.

The gas-analysis instrument tells exactly what is taking place in the boiler furnace and with all of the certainty that the steam-engine indicator reports upon conditions inside the engine cylinder.

Anybody can understand and operate an engineer's gas-analysis instrument. Ordinary firemen can work it. No knowledge of chemistry, whatever, is required. Any man with sense enough to read a scale can make a perfectly correct analysis of the flue gases.

It may be explained to the fireman that the matter of cold air should be further investigated, and that here is a machine that tells all about it. It has a tube with a scale etched on it like a thermometer glass. The tube is filled with chimney gas until the water goes down to the zero mark. Then the gas is passed over into this other compartment which is filled with lye. The lye soaks up all of the coal gas and leaves nothing but air. When the soaking operation has been accomplished, the scale is read. It ought to register 14 or 15 per cent. coal gas and about 85 per cent. air. The more gas found, the less air heated, and *vice versa.* The fireman is interested; this is something he can understand, and in 15 minutes he is actually working the gas-analysis instrument like an expert. If any permanent and substantial benefit is to be derived from flue-gas analysis it is necessary that all of the firemen in the plant should be interested. Place a bonus on efficiency. This will bring the men into line if nothing else will. The results are most gratifying when the men know what the work means. It is important that the business of checking up the furnaces and the firemen should be made a part of the daily routine.

If the flue gases show around 14 per cent. CO_2 and no CO, the furnace and the firemen are doing all that can be expected of them. The percentage of CO_2 can be determined in one minute and the percentage of CO in five minutes. The percentage of CO_2 is a recognized measure of the volume of excess air.

The difference in economy between 14 and 10 per cent. CO_2 is around 5 per cent. of the fuel; between 14 and 5 per cent. CO_2, 23 per cent. of the fuel; and between 14 and 2 per cent. CO_2, 75 per cent. of the fuel. Furnaces have been worked with less than 2 per cent. CO_2.

The benefits that come from the use of gas-analysis apparatus in the boiler room are twofold:

1. The apparatus, as already stated, diagnoses the case of the boiler furnace for the engineer.

2. The apparatus keeps a check on the firemen and turns in a report at the end of the day on each one of them. If the CO_2 results are posted daily where the men can see them and a summary of the results at the end of the month, the firemen will do the rest and the fuel bills will go down as the percentages of CO_2 come up. The bonus system has been tried with good results in a number of large power plants. Pay the firemen a premium for high CO_2 averages. The company can afford to give the fireman an extra dollar when he is saving ten. It is in the nature of every man to be more attentive to business when he is under inspection.

There are hundreds of CO_2 recorders standing unused in the dark corners of power plants. The trouble was not with the machines but with the people who bought them and the others who sold them. It is one thing to possess a recorder; it is another thing to make proper use of the apparatus after its purchase.

In a large power plant equipped with four CO_2 recorders, the machines were registering from 4 to 6 per cent. of CO_2. The manager complained that there was nothing to be gained from using flue-gas analyzers; that his coal bills were just as heavy as they were before the recorders were installed. He produced a pile of charts and there was not a decent one among them. It was then pointed out to him that the business of a CO_2 recorder is to report conditions as they are and not as they ought to be. Every one of the charts was a protest against a preventable waste of nearly 25 per cent. of the fuel. Upon investigating the conditions it was discovered that the hoppers of some of the chain-grate stokers were running half empty. The fires were running short under all of the boilers. The settings were all in need of repairs. The cracks were so large in some places that the flames could be seen playing in the first passes of the boilers. The load could have easily been carried on two-thirds of the boilers and two-thirds of the coal.

It is one thing to attain high efficiency; it is another thing to maintain it. There is no apparatus that can compete with a good hand-analysis set in searching out trouble and building up furnace efficiency. There is no instrument more efficient than a CO_2 recorder in maintaining efficiency after it has been attained.

In order to measure air leakage, gas must be simultaneously sampled from two places, the first pass of the boiler and the breeching. The leakage may be computed from the difference of the CO_2 content of the gases at these two places. The recording apparatus can only work at one place at a time. It is not practical, furthermore, to connect the recorder at any place but the uptake or breeching. Questions of temperature and mixture enter the problem when a permanent sampling tube is inserted into the gas passages of the boiler.

In checking up a boiler furnace it is necessary to identify each gas sample analyzed with observed furnace conditions. If the CO is low there is a reason for it and the cause must be found. For example, a crack or a "rat hole" is noted in the fuel. To what extent is the air leak responsible? The engineer wants to know, and he wishes to give the fireman an object lesson. It takes one minute to get a sample of gas into the hand instrument and determine the percentage of CO_2. The volume of excess air flowing through this leak is measured. It is surprising to note the quantity of nullifying cold air for which the leak is responsible. The effect of covering the air leak is shown by the analysis. The fireman will be impressed and he will watch for these leaks in the future.

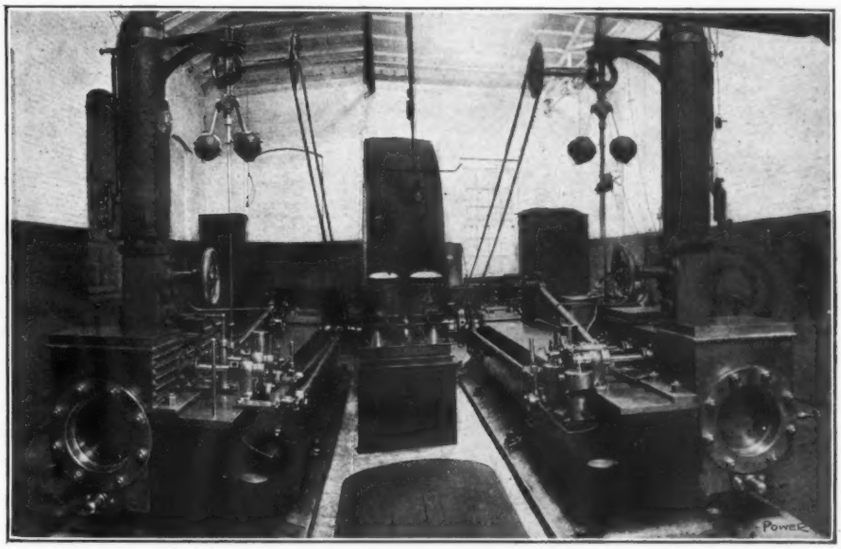
A patent has just been issued to Rosendo Ladron de Guegara, of Vera Cruz, Mex., for a boiler disincrustating compound consisting of 100 parts calcium oxide, 20 parts of pulverized baked clay, 15 parts of refined petroleum, 35 parts of the juice of agave leaves, one part of carminic acid, two parts hydrochloric acid.

A Pair of Old Engines

By A. Heaton

The installation of a central power plant with electric transmission of power to the different buildings, at the old plant of the Wheeler & Wilson Manufacturing Company at Bridgeport, Conn. (now the Singer Manufacturing Company's plant No. 10), has put a number of engines out of commission which have done good service in the past. The illustration shows the pair which drove the main machine shop, and which have just completed a run of 44 years and 3 months without being shut down during working hours to exceed a total of one and a half hours during the whole period.

They were built by the Pacific Iron Works, and had a fixed cutoff and throttling governor, but in 1882 the right-hand one was fitted with the Heaton automatic cutoff, which was illustrated in the September, 1890, issue of Power.



Engines after 44 Years of Service

The series of comparative cards shown in Houghtaling's book on "The Indicator and Its Appliances," which illustrates the difference in water consumption between automatic and throttling engines at the same load, was taken from this pair.

Both the speed of the engines and the boiler pressure have been increased twice during their term of service in order to meet the increasing demands for power, and, although laid off for the summer, they are still rated A-1 and are ready to be put into service in an emergency.

It is estimated that 250,000 electric flat irons were sold in the United States and Canada last year. There are more than 10,000,000 homes within central-station territory, of which fewer than 2,000,000 have electric service; consequently the estimated sales last year approximate one iron to every eight homes.

Flow of Water in Clean Iron Pipes

By Albert E. Guy

Concluding article of a series upon the development and use of the "alinement chart" as applied to the flow of water in pipes. The present chart gives the horsepowers equivalent to various quantities of water at different heads.

In the preceding articles of this series an attempt was made to show the resemblance between operations on a slide rule and those performed on a three-line diagram. The problems used as examples were rather crudely worked out, and the reader may conclude, after perusing the present article, that the order has been unduly reversed; that is, the theory should have been expounded first and followed by the examples. However, as the practical man is inclined to make light of "so called theory," it was deemed best to adopt the method used. With this as a basis the formulas may now be put into a more concise form, and their derivations explained.

In its simplest form the slide rule consists of two duplicate scales capable of being slid past one another. On each a given number is represented by its log-

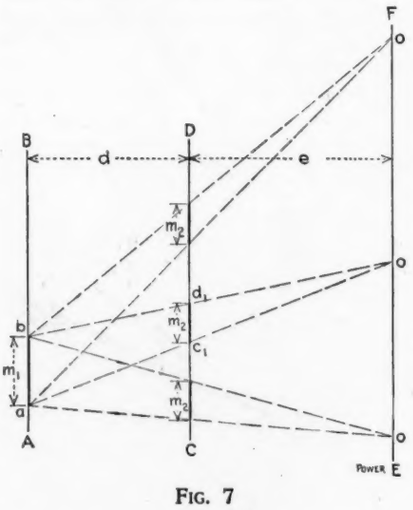


FIG. 7

arithmic length measured from the origin of the scale, marked "1," to the division representing the number. To multiply a number A by a number B, to the length $1 - A$ on one scale is added the length $1 - B$ on the other scale; the sum is read directly on the first scale, but the graduation of this scale is such that the reading recorded is exactly $A \times B$. Division is accomplished by subtracting one length from another.

Likewise, with three-line diagrams, multiplication or division is effected by the addition or subtraction of logarithmic lengths of numbers, but with these differences:

The number A is read on one scale, B on another, and the result C on a third scale. On the slide rule the logarithmic length of one number is the same on each scale, whereas on the diagram this length may be different on each of the scales. In short, a three-line diagram may be considered as composed of three specially constructed "slide-rule scales" properly spaced and set so that, by means of a straight-line index, an equation of the form

$$A^x B^y = C^z$$

may be solved at one reading.

In addition and subtraction, the quantities added or subtracted must be of the same kind. To satisfy this requirement, the scales of the diagram must be so located that the index, placed in any given position, will automatically reduce the large scale and increase the smaller, so that, as measured on the third scale, the logarithmic length spaced off on each will be that of the same number.

The scales $A\,B$, $C\,D$ and $E\,F$, Fig. 7, are parallel and fixed, and no matter how the triangle $a\,b\,o$ is placed, provided its base ($a\,b = m_1$) remains on the scale $A\,B$, and its vertex o on $E\,F$, the intercept ($c_1\,d_1 = m_2$) will always be on scale $C\,D$ and its length will remain constant. The ratio $\frac{m_1}{m_2}$ is a constant and

$$\frac{m_1}{m_2} = \frac{d+e}{e}$$

In Fig. 8, the logarithmic length of the number 10 is m_1 for scale $A\,B$, m_2 for $C\,D$, and m_3 for $E\,F$. This length is called the *modulus*. It takes one modulus for the number 10, two moduli for 100, three for 1000, four for 10,000, and so on.

By joining point A to the point representing 10 on $E\,F$, and E to that representing 10 on $A\,B$, the two lines intersect precisely on the point representing 10 on $C\,D$. From this the relation between the three moduli can be obtained.

As in Fig. 7,

$$\frac{m_1}{m_2} = \frac{d+e}{e}, \text{ and } \frac{m_3}{m_2} = \frac{d+e}{d}, \frac{m_1}{m_3} = \frac{d}{e}$$

Whence,

$$d = e\,\frac{m_1}{m_3}$$

and

$$e = (d+e)\frac{m_2}{m_1} = \left(e\,\frac{m_1}{m_3} + e\right)\frac{m_2}{m_1} =$$
$$e\,m_2\left(\frac{1}{m_3} + \frac{1}{m_1}\right)$$

and

$$\frac{1}{m_1} + \frac{1}{m_3} = \frac{1}{m_2} \qquad (16)$$

From this

$$m_1 = \frac{m_2\,m_3}{m_3 - m_2}$$
$$m_2 = \frac{m_1\,m_3}{m_1 + m_3} \qquad (17)$$
$$m_3 = \frac{m_1\,m_2}{m_1 - m_2}$$

The position of the scale is determined by equation

$$\frac{d}{e} = \frac{m_1}{m_3}$$

With these formulas the problem is entirely solved.

To test the correctness of the diagram thus established, join point 100 on $A\,B$ to point 10 on $E\,F$; also, 10 on $A\,B$ to 1000 on $E\,F$; the corresponding readings on $C\,D$ will be respectively

$1000 = 100 \times 10$ and $10{,}000 = 10 \times 1000$

From this it may be inferred that the product of any number on $A\,B$ by any number on $E\,F$ will be read on $C\,D$ with the degree of accuracy aimed at when the diagram was established.

As explained in the preceding articles, the products just obtained are the logarithmic sums as read on $C\,D$ of the

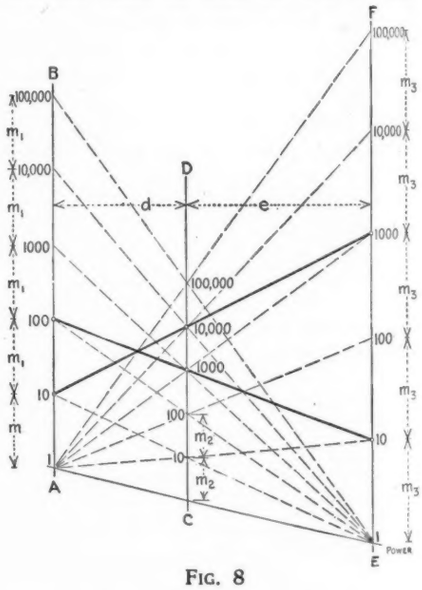


FIG. 8

parts spaced off on the other scales. Thus,

$1000 = 2\,m_1$ (on $A\,B$) $+ m_3$ (on $E\,F$) $=$
$2\,m_2 + m_2$ (on $C\,D$)

and

$10{,}000 = m_1$ (on $A\,B$) $+ 3\,m_3$ (on $E\,F$)
$= m_2 + 3\,m_2$ (on $C\,D$)

Usually the datum line $A\,E$ does not appear in a finished diagram.

The graduations of the scales will depend upon the equation represented and may be different from those of Fig. 8; for example, let the equation be

$$G = P^2\,R^3$$

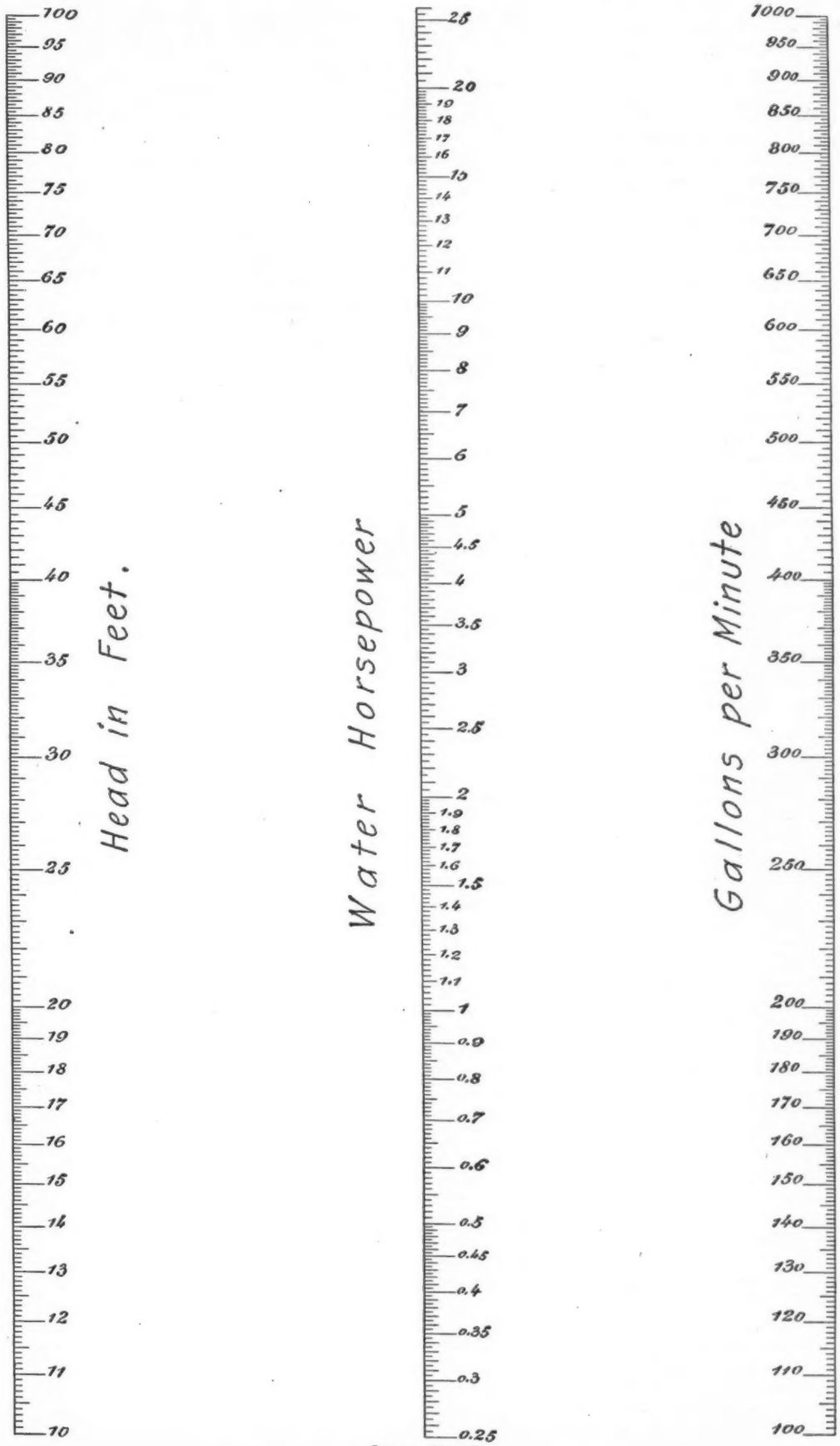


CHART NO. 3

If any two of the factors represented by the scales are known, the third may be found by passing a straight line through these quantities on their respective scales. The line will intersect the third scale at the number representing the desired factor.

the value P being read on $A\,B$, R on $E\,F$ and G on $C\,D$. Selecting, for example, a value of the equation where P equals 12 and R equals 8,

$$G = \frac{12^3}{8^3} = 144 \times 512$$

In order to find the value of G it would be necessary to join point 144 on $A\,B$ to point 512 on $E\,F$ by a straight line cutting $C\,D$ precisely at G. But these numbers, 144 and 512, are not at hand, and it is precisely for the purpose of saving the trouble of figuring them and the more difficult task of reading them accurately on the scale that the whole diagram is established. Hence, the scale of R should be made with a modulus M_3, such that when a number as $R\ (=10)$ is used, although this point on the scale would read only 10, it would correspond to a value of 10^3, or 1000. And, although it might be stated that the modulus of R is M_3, this being equivalent to the logarithmic length of the number 10, at the same time it would be well understood to equal three times the length of m_3, because on scale $E\,F$, 1000 equals $3\,m_3$. Likewise, the modulus of P, on $A\,B$, would be M_1 (equal to $2\,m_1$) because on $A\,B$ when P equals 10 or M_1; in reality it represents

$$P^3 = 10^3 = 2\,m_1$$

The general form of the equation solved with a three-line diagram being

$$A^x \quad B^y \quad = \quad C^z$$

and adopting m as the modulus or logarithmic length of the number 10, this equation, treated by logarithms, becomes:

$$x\ log.\ A + y\ log.\ B = z\ log.\ C$$

and

$$x\,A\,m_1 + y\,B\,m_3 = z\,C\,m_2$$

If the scales are to express the true value of each function, such as A^x, although simply marked A, the moduli adopted for the three functions may be M_1 for A^x, M_2 for C^z, M_3 for B^y, and the general equation will be:

$$[A^x B^y = C^z] = [x\,A\,m_1 + y\,B\,m_3 = z\,C\,m_2] = [A\,M_1 + B\,M_3 = C\,M_2]$$

If this reasoning be applied to the calculation of Chart No. 2, shown in the preceding article, the ease with which the necessary elements can be established, as compared with the somewhat laborious process followed before, will be at once apparent.

Neglecting the constant, the equation in connection with this chart was

$$Q = D^2\,V$$

Q being on the first scale, V on the third, and D^2 on the second. The equation may be written

$$Q\,M_1 = D\,M_2 + V\,M_3$$

It was found convenient to use the moduli $M_1 = 83\frac{1}{3}$ millimeters, and $M_3 = 125$ millimeters, with $d + e = 170$ millimeters.

Applying equation (17)

$$\left(m_2 = \frac{m_1 m_3}{m_1 + m_3}\right)$$

$$\frac{M_2}{2} = m_2 = \frac{M_1 M_3}{M_1 + M_3} = \frac{83\frac{1}{3} \times 125}{83\frac{1}{3} + 125} = 50$$

whence,

$$M_2 = 50 \times 2 = 100\ millimeters$$

Then,

$$\frac{d}{e} = \frac{M_1}{M_3} = \frac{83\frac{1}{3}}{125} = \frac{2}{3}$$

$$d = \tfrac{2}{3}\,e,\quad d + e = \tfrac{2}{3}\,e + e = \tfrac{5}{3}\,e = 170$$

$$e = \frac{170 \times 3}{5} = 102\ millimeters$$

$$d = 170 - 102 = 68\ millimeters$$

The location of the constant depends upon the conditions of the problem, and also upon the most preferred arrangement of the scales on the diagram. When, as in Chart No. 2, the constant is introduced on the second scale, either of two ways may be followed. At the intersection D^2 on $C\,D$ of a straight line joining two points Q and V, selected on $A\,B$ and $E\,F$, the value of the constant, expressed with a logarithmic length of modulus m_2, is spaced off on $C\,D$, either above or below D^2, as the case may be, and the scale is then laid out with D^2 located at the point just found. Or, the equation may be solved with the constant, as has been done, for a given value of Q and D^2, thus obtaining the corresponding true value of V. A straight line joining these Q and V intersects $C\,D$ at the exact location of D^2, and the scale of the diameters (D) is laid out as in the first instance.

Horsepower Chart

When a quantity of water Q weighing W pounds is raised through a hight H feet, the power expended, independent of frictional losses, is

$$W \times H\ foot\text{-}pounds$$

The quantity is expressed in cubic feet or in gallons. In matters concerning waterworks or pumping installations, Q is expressed in gallons per minute (g.p.m.), in million gallons per 24 hours or in cubic feet per second. The engineer usually deals with gallons per minute; hence, when estimating, the other values are transposed into gallons per minute.

One United States gallon is equal to 231 cubic inches or 7.4805 cubic feet. One cubic foot per second equals

$$7.48 \times 60 = 448.8\ g.p.m.$$

or, with sufficiently close approximation, 450 gallons per minute may be used. One million gallons per 24 hours equals

$$\frac{1{,}000{,}000}{24 \times 60} = 694.445$$

approximately 700 gallons per minute.

It is usual in calculations to assume the weight of one cubic foot of clear water at 62 degrees Fahrenheit to be 62.355 pounds.

The water horsepower (w.hp.) corresponding to $Q \times H$ foot-pounds of work done is:

$$\frac{G.p.m. \times H \times 231 \times 62.355}{1728 \times 33{,}000} = \frac{G.p.m. \times H}{3958.9}$$

With the constant in round figures, this becomes:

$$Water\ horsepower = \frac{G.p.m. \times head}{3960} \qquad (18)$$

The hight H is usually termed the head. When the water is discharged against a pressure of P pounds per square inch, the corresponding head is

$$P \times 2.309$$

Equation (18) transformed, becomes:

$$log.\ (w.hp.) = log.\ (G.p.m.) + log.\ (Head) - log.\ 3960$$

After a few trials it is found most convenient to put the head on scale $A\,B$ with M_1 equal to 250 millimeters, *G.p.m.* on $E\,F$ with the modulus M_3 equal to 250 millimeters, and the *w.h.p.* on $C\,D$ with a modulus M_2.

Equation (17) gives

$$M_2 = \frac{M_1 M_3}{M_1 + M_3} = \frac{250 \times 250}{250 + 250} = 125\ millimeters$$

$d + e$ is selected equal to 143 millimeters; hence, since

$$\frac{d}{e} = \frac{M_1}{M_3} = 1$$

$$d = e = \frac{143}{2} = 71.5\ millimeters$$

The first and third scales are each laid out with a 10-inch slide-rule scale 250 millimeters long; then, after solving equation (18) for one set of values of *G.p.m.* and of H, a line is drawn joining these two points on the $A\,B$ and $E\,F$ scales, and intersecting $C\,D$ at the precise corresponding value of the horsepower. The *w.hp.* scale is then drawn with a 10-inch slide-rule scale of squares, 125 millimeters long, the number on the scale coinciding exactly with the number at the point just determined on $C\,D$.

This chart is made to read directly on $C\,D$ the water horsepower corresponding to a head ranging from 10 to 100 feet, with a quantity varying from 100 to 1000 gallons per minute. Should the head dealt with be greater than 100 feet, say 265 feet, for example, while the gallons per minute are between 100 and 1000, then the water horsepower corresponding to 26.5 feet should be read on the middle scale, and this reading multiplied by 10 would be the required horsepower.

For a quantity greater than 1000 gallons per minute, say 7550, the water horsepower corresponding to 755 gallons per minute would be read on the middle scale, and the reading multiplied by 10 would again give the water horsepower required.

The process would be the same for heads and quantities simultaneously greater than the scale limits; thus for 265 feet and 7550 gallons per minute, the reading obtained would be that corresponding to

$$\frac{26.5 \times 755}{3960}$$

and that, multiplied by

$$(10 \times 10) = 100$$

would be the required water horsepower.

How Mat Made Good and Then Lost

By Luke Marier

By hard work and diligent application to his studies Mat worked himself up from fireman to chief engineer with a first-class license. With his ambition satisfied Mat became careless and drifted back to a miserable failure more rapidly than he had risen.

Let me assert that if I ever read an interesting bit of literature it certainly was the editorial which appeared on the first page of POWER for March 28. It is real, true and practical—and the admonitions it contains should unquestionably actuate the average engineer who, through long years of trudging in the same old habits, has forgotten himself and laid his studies aside long ago; that is, if he studied at all.

It would be well for all of us to read that same editorial again and thoroughly absorb its wholesome advice.

Health is quoted as being a valuable asset, for an engineer. The following is the story of two engineers; it illustrates what an important part health plays in a man's career.

Matthew Ella was the son of a very poor couple, totally ignorant of the English language and just emigrated from Canada. He was full of ambition and energy; and possessed a bulldog determination to succeed.

Shortly after he arrived in a certain New England city, he secured a small job as carpenter's helper. Soon after this he made the acquaintance of the night fireman of the F. R. B. Company, and came regularly to spend his evenings in the plant with his friend, cleaning out furnaces, etc.

The steam-engineering field seemed alluring to this young man, and he got all the pointers he could on boilers and auxiliaries from his new friend. He also got well posted on questions which might be encountered during an examination. Invariably he would remain and work strenuously until midnight, in spite of the fact that his regular work during the day was most tiring.

After a couple of months—worn and pale as a ghost—he applied for a first-class fireman's license and got it. Immediately he took charge of a fireroom in a large cotton mill where there were 10 horizontal tubular boilers. But after a week he was compelled to descend to coal wheeling because of his inability to "make good." This did not discourage him, but instead, made him realize he needed experience.

Three months elapsed before he made any headway. This time, he accepted the "dignified" position of oiler in the L—— L—— mills, and "made good." He remained in this position for about 18 months. During this time he got somewhat entangled in things matrimonial and presently "tied the fatal knot."

About this time he was offered another position for more money and he accepted without a question. All the while, Mat studied incessantly on a well known correspondence-school course and acquired an ever-increasing degree of proficiency in the English tongue. He also studied with a private instructor who gave him many "good pointers" or "jewels" as they were called. These "jewels" played a mighty important part when at length he was examined for a first-class engineer's license, which he secured.

Next, Mat became assistant engineer in the M—— mills, where he made himself valuable in many ways. He operated one plant while the chief made his headquarters at the other plant across the road, perhaps five minutes' walk away.

It was on a Thursday morning that the chief came to see Mat's "big license." Mat, anxious to show the chief his beloved "ticket," pulled it from his pocket with alacrity and handed it over with a smile. The chief examined it with a frown and a look of displeasure. "What is this good for anyway?" demanded the chief. "Will this help to run the plant any better or any more economically?"

"Well, this surely will mean, at the very least, $2 more in my pay envelop," replied Mat, whose smile had instantly changed into a frown like the chief's. "And if I can't get the increase here I can get it somewhere else," he added.

This sort of talk naturally aroused the chief and enmity was created. Mat began to keep an eye open for a vacancy somewhere.

Presently the job at the L—— L—— mills was open and as Mat was familiar with the plant there, he immediately applied for the position and was fortunate enough to get it. He was placed in full charge at a salary of $22 a week, the largest sum he had ever seen in an envelop up to this time.

This plant was located some two miles from his home, which distance he cheerfully plodded morning and night. This was indeed healthful for him, he was pale no longer, but instead, had the color in his cheeks which he had totally lost during the five years of hardship. He steadily increased in weight and eventually this plodding got to be commonplace. He began to feel considerable dignity and soon required a larger-sized hat and perhaps the removal of a few buttons from the upper part of his vest to allow for chest expansion.

All this led him to the purchase of a horse and buggy. He had reached the goal of his ambition and was in a mood now "to take things easy." He grew indifferent from doing so little and let things about run themselves.

His mind became centered on "money making." Most every night would see him make the rounds of his acquaintances in an endeavor to sell them jewelry, in which there was a handsome profit, some 50 per cent. to be realized on every sale. This formed a sort of side business, which proved to be quite remunerative. He once told me that he never sent less than $30 to the bank every week. Shrewd and saving he certainly was.

However, this business did not adjust his engines nor repair his boilers, which soon got to need a general overhauling. The fires of ambition and interest were dying out. He said to me one day that he was not paid for what he did but, rather, for what he knew. This was simply idiotic!

Everything had been very well adjusted and as "clean as a whistle" when the plant was turned over to him and this had enabled him to "take it easy." And, so he did—but his stomach did not, especially from the time he purchased the horse and buggy. It became mighty difficult to digest, say, a good heavy bit of fried steak or a generous portion of clam chowder, especially if it was half cooked and prepared in a hackneyed fashion. After a feast on such things he would doze for the rest of the afternoon in his arm chair. Imagine what beautiful unprintable language his stomach would have uttered had it been able to speak!

Johnny B—— often advised him to exercise but such advice was simply futile—he was too arrogant now to take heed. He often told me that he had worked and studied so extremely hard to obtain his license that now he intended to rest, so he did. He was loath to study ever since he took charge of this plant, studying was simply repugnant to him and he read but one cheap technical magazine.

Months slipped away, and so did the pink in poor Mat's cheeks. He got to be indifferent from doing so little and repairs were utterly neglected. A deplorable condition of affairs soon came to exist.

One afternoon while visiting his plant, my attention was attracted by the constant thudding of the eccentric on the

tandem-compound Corliss engine. I observed that the eccentric strap held by merely the top bolts, the bottom bolts had fallen into the oil tray below. Further observation showed that cylinders were cutting; boilers were in need of resetting; the other engines needed as thorough an overhauling as did the Corliss; the condensing system was in very poor condition; in a word, everything was on the verge of complete dilapidation.

Finally, after being in charge for 22 months, Mat took sick and two weeks after died. Poor fellow, but perhaps this was as fortunate for him as to be suddenly destroyed by a bursting cylinder head. His headquarters were directly abreast of the high-pressure cylinder of the tandem-compound Corliss engine, one of the eccentric straps of which held only by the top bolts.

Mat had often boasted that it would be quite a difficult matter for the company to find a stranger to run his plant successfully should he ever leave, since this plant was so differently constructed than any other he had seen.

"My dear friend," I said, smilingly, "should you leave this job this very minute, there would be a dozen capable applicants ready to fill it in half an hour."

He smiled and could not believe it.

At any rate, this is just the condition of affairs which existed when he died. Some ten or fifteen good, capable men applied. The one who was selected was a brilliant sort of fellow, level-headed, well read—a gentleman, one you may meet in every hundred engineers, one who attends strictly to business. This man was an engineer worthy of the name; always on the alert, always attending to even the most trivial things with care and precision; he was a master. He remained in charge for some 18 months, during which time he overhauled everything from sump pit to chimney top. The finest thing about this *gentleman* was that his head always remained at its normal size.

When finally he moved up another rung, he accepted a job as chief engineer in New Bedford, Mass., for some $15 a week more than he was receiving at this place.

Vapor Heating Systems*

By Thomas G. Mouat

About twenty-six years ago a journeyman steamfitter remarked to the writer that vapor was the coming heat. Upon being asked what he meant by the term "vapor," he replied that it was steam slightly above atmospheric pressure. In those days it was deemed necessary to carry from 1 to 10 pounds of steam pressure in order to heat a building successfully with the ordinary gravity low-pressure system without the means of producing a partial vacuum; and most boiler manufacturers still set the pop valves to blow at 15 pounds.

This steamfitter's prophesy has been realized, and, although it is a long step from 10 pounds to 2 ounces pressure, it has been practically demonstrated that a building can be heated in the coldest weather with from 2 to 3 ounces pressure, and the term "vapor heat" is now applied to a steam-heating system which operates under this very low pressure.

The main object of vapor heating is to provide for a system that will operate with just a little heat turned on each radiator, enough heat to be comfortable without overheating in moderate weather and plenty of heat for the coldest days, by simply opening the supply valves a little further. Several attempts were made from time to time to perfect a system, which would permit the partial heating of the radiators, but in each case they met with failure, due to the inability to control the pressure with the ordinary diaphragm damper regulator and devices of this character, where the steam pressure was directly applied to do the work. It was not until the direct application of steam in connection with a diaphragm was dropped, and the agency of water plus the steam pressure was employed that a system permitting positive and practical graduation was perfected. The graduated admission of steam to each radiator may now be accomplished in a properly constructed vapor system by the use of a sensitive pressure and damper regulator attached to the boiler with fractional valves and special return fittings on the radiators, and an opening in the return pipe near the boiler to permit the escape of air. No air vents are used on the radiators.

The regulator must be so constructed that it will open or close with the variation of an ounce of pressure. This result has been obtained by a regulator operated according to the principle of a hydraulic balance, water being forced out of a stationary tank into a movable tank placed at the end of a lever which causes the movable tank to tilt downward and close the dampers. When the pressure has dropped an ounce, part of the water leaves the movable tank and returns to the stationary tank; the former is then tilted upward by the aid of a counterweight and the reverse operation occurs.

There is also a regulator on the market operated by a float in a tank placed alongside of the boiler. When the water is forced out of the boiler the float is raised and the drafts are closed. When the water in the tank drops back into the boiler again, the float descends and the dampers are opened.

The graduating valves are constructed so as to permit a small amount of steam to enter the radiator, so little that it will be condensed in heating a small portion of the radiator; or, on the other hand, they may be opened still farther and heat the entire radiator. The valves are furnished with stop screws so that they may be set to heat the entire radiator without permitting any steam to pass through the radiator into the return pipe.

Water radiators are used, which heat horizontally along the top first and thence downward according to the amount of steam turned on. The return fitting is placed at the opposite end and is connected to the bottom connection of the radiator. This return fitting is constructed with a small water seal which presents a full opening for the flow of condensation into the return pipe, and a restricted opening for the escape of air into the same pipe. This restricted opening and water seal retard the flow of steam into the return pipe. The air and water travel together to a point near the boiler where an opening for the escape of the air is provided in the top of the return pipe. From this a pipe leads to the chimney flue, where a slight reduction in pressure is produced, tending to help the removal of the air. The water separated from the air falls to the boiler.

The ordinary steam-heating system with its variable pressure, uncertain regulation and the tendency toward a vacuum will not permit of any graduation. A sufficient reduction of pressure in the radiator would immediately fill the radiator with water through the return pipe; or in a one-pipe system the radiator would gradually fill with water if the supply-valve area was materially decreased. No vacuum can be produced in a vapor-heating system of this type because, as has been already stated, it is open to the atmosphere. With the ordinary steam-heating system the supply valves must be either turned on full or shut off tight, which frequently makes the rooms either too hot or too cold, causing waste of fuel and discomfort.

With the vapor-heating system, however, the pressure is generally much higher in the supply pipes than in the radiators. It may be 2 ounces in the pipes and only a small fraction of an ounce in the radiators, due to graduation and condensation. The water of condensation returns to the boiler at a very low temperature, averaging about 85 degrees Fahrenheit, and with some vapor systems the return water may be reheated by means of the waste gases.

There are many other reasons which recommend the vapor system to the public. The very low pressure at which the system operates reduces the cost of maintenance to a minimum. It is noiseless in operation, and is economical due to the sensitive regulation, the very low pressure and the graduation. Furthermore, it is capable of keeping up a steady heat from 10 to 12 hours

*From a paper delivered before the Ohio Society of Mechanical, Electrical and Steam Engineers, at Youngstown, Ohio, May 18, 1911.

with hard coal without attention. There are no air vents to leak, sputter, or emit odors into the rooms, and it is much quicker to act than hot-water heat, and the danger from leakage or freezing is reduced to the minimum. The radiators are smaller than those used for hot water, and about 15 per cent. larger than those required for the ordinary steam systems. When natural gas is used for fuel, the regulator is attached to a butterfly valve on the gas-supply pipe, which prevents overpressure and makes the system almost automatic, with the exception of turning the valves on and off at the radiators.

Boiler and Flywheel Explosions in America

It may be of interest to read what our British contemporary, the *Mechanical Engineer*, has to say in regard to boiler and flywheel explosions in the United States, and incidentally a few side remarks on American recklessness.

The United States maintains its unenviable position as record breaker in respect to accidents from the working of power plants. According to *The Locomotive*, a little publication issued by the Hartford Boiler Inspection and Insurance Company, there occurred last year no less than 533 explosions of boilers, killing 280 persons and injuring 506 others. As compared with the rate of fatality in this country the figures are astounding, and, moreover, are in no ways exceptional. There were 550 explosions in 1909, while the average for the previous four years was 455, with a similar proportion of killed and injured. It is difficult to compare these figures exactly with similar ones in this country, because the exact number of boilers in the States is not known, while the above figures only refer to the results of explosions of boiler shells and do not include the multitude of minor fatalities and scalding cases arising from the failure of steam pipes and subordinate details of steam apparatus, which, however minute, and whether on land or afloat in any vessel flying the British flag, come under the purview of the Boiler Explosions Act, and hence are included in the annual returns. Taking this sweeping inclusion, the average number of failures for the past ten years only works out at 68 per annum, with a fatality of 23 and a list of injured of 52. Were such minor failures as are embodied in these returns included in the statistics given by our contemporary, they would, of course, be greatly increased. But if we neglect them, it will be seen that, roughly speaking, the comparison is about ten to one. There are, no doubt, a larger number of boilers in the States than here; exactly how many it is impossible to say, though if we assume twice as many, a very liberal estimate, the figures imply a recklessness and absence of supervision in the States which is serious.

Similar recklessness appears to characterize the working of engines as of boilers, judging from a list of flywheel bursts recorded by our contemporary during 1910, which is admittedly incomplete since it rests mainly on the reports of such accidents as were sufficiently important to secure notice in the press. The list gives details of 67 accidents of this kind, causing the deaths of 16 persons, and more or less serious injury to 28 others. A perusal of the details, where these could be obtained, show that in a great many cases the accidents were due to the failure of the governing mechanism, though we cannot help feeling that the structural weakness of flywheels usually fitted to prime movers in the States, and the correspondingly small margin between safe and bursting speed, is responsible in considerable measure for the frequency of failure.

Duffy Wants a "Picture"

By Danny Hogan

"An' how's the laundry?" asked Doolin.

"Fine," replied Duffy, "the boss wants me to take out a license an' be the engineer as Cogan is drinkin' again."

"An why not?" asked Doolin, "you've been there seven years doin' this and that an' by rights you should know enough to get a picture for the frame."

"I know," says Duffy, "but I dunno if I could answer the questions about bilers. I'm told one must know all about riveting an' I'm no biler maker at all.'

"True for ye," said Doolin, "an' biler makin' is one of the grandest studies we have. There ain't, Duffy, within reason, annything made by man that equals for profound interest an' deep research, a steam biler. An' the older it is, the more interesting it becomes. Ye would need years to learn the line. But there's no call, Duffy, for you to learn biler makin' to be an engineer. The City Hall gang ain't biler makers either. They will ask you some questions from a book and look at the answers an' find out if you are right.

"They will ask you, no doubt, to lay out a lap-joint seam for ⅜-inch plate at 56,000 pounds tensile strength and how to find the thickness of plate for a 60-inch biler, 100 pounds pressure, with a double-riveted seam."

"I couldn't do it," said Duffy.

"In one hour," replied Doolin, "ye can learn it all an' can get a job as a layer out."

Mr. Doolin filled his pipe and on some manila paper proceeded to lay out as follows:

P = Pitch of rivets;
WP = Working pressure allowed;
F = Factor of safety, 5;
R = Radius or ½ diameter;
T = Thickness of plate;
TS = Tensile strength of plate;
D = Diameter of rivet hole;
A = Area of rivet hole;
N = Number of rivets in a pitch;
S = Shearing strength in single shear;
RE = Rivet efficiency;
PE = Plate efficiency;
E = Lowest efficiency.

$$WP = \frac{TS \times T \times E}{R \times F} \quad (1)$$

$$RE = \frac{A \times N \times S}{T \times TS \times P} \quad (2)$$

$$PE = \frac{P - D}{P} \quad (3)$$

$$T = \frac{WP \times R \times F}{TS \times E} \quad (4)$$

$$E = \textit{Lowest of } (2) - (3) \quad (5)$$

$$P = \frac{A \times N \times S}{T \times TS} + D \quad (6)$$

$$F = \frac{TS \times T \times E}{R \times WP} \quad (7)$$

$$R = \frac{TS \times TE}{F \times WP} \quad (8)$$

"There, Duffy, ye have," said Doolin, "the data, so as to speak, of lap seams either single, double or triple riveted. An' with that ye can use some short cuts. For instance, firebox steel may be taken at 56,000 TS and the shearing strength of steel rivets is 42,000 pounds. Now, 56,000 is to 42,000 as 3 is to 4.

"In finding P you can drop the large figures and with $\frac{5}{16}$-inch plate and ¾-inch rivet hole make it

$$P = \frac{0.4417 \times 2 \times 3}{0.3125 \times 4} + 0.75$$

an' P will be 2.87 inches, or 2⅞ inches. Now, what is the efficiency of this, ye will ask. Well,

$$PE = \frac{2.875 - 0.75}{2.875} \textit{ or } 73 + \textit{per cent.}$$

$$RE = \frac{0.4417 \times 2 \times 3}{0.3125 \times 4 \times 2.875} \textit{ or } 0.73 + \textit{per cent.}$$

Ye will note, Duffy, that PE and RE are equal. Some prefer to favor the plate over the rivet, having in view that with the "bull" the rivet will surely fill the hole an' the plate may be hurt in the bending rolls. But, if you increase the pitch by so much you reduce the calculated E of the joint. Now, ye can work over these matters until your head is full and ye will get the picture to frame."

"But," says Duffy, "how will I know what size rivet to use for a given thickness of plate?"

"That's right," replied Doolin. "Well, 'tis this way: With plate of from ¼ to $\frac{9}{16}$ inch ye can use

$$\textit{Thickness} \times 2$$

to find the diameter of rivet hole. Practice varies on this. Some use

$$T \times 2 - \tfrac{1}{16} \textit{ inch}$$

and some,

$$T \times 2 + \tfrac{1}{16} \textit{ inch}$$

but $T \times 2$ gives common practice an', further, a tight job. Another thing, Duffy,

is important. Suppose we lay out a straight line to be the pitch line, we must now find the distance from this line to the edge of the plate for the joint might fail by crushing out in front of the rivet. Ye should allow 1½ diameters of rivet for this distance an' if you use $T \times 2$ for the diameter the matter of the plate crushing out will be properly taken care of."

"What is the allowance for steel plate crushing in this way?" inquired Duffy.

"The rule to find this," said Doolin, "is

$$D \times T \times 95{,}000$$

With the 5/16-inch plate and ¾-inch rivet hole, this equals 22,266 pounds, showing it is stronger than the shear of the rivet. In designing one must look after this crushing detail the same as the rivet shear and the net plate efficiency; so bear that in mind. The City Hall bunch may spring this on ye so it's well ye go over it and absorb it in your system."

"I will," says Duffy, "but there is one thing else I never understood. How do you find the distance between pitch lines on double and triple rows? Tell me that."

"Well," said Doolin, "the authorities vary on this point also. For instance, many rules ignore the matter, important as it is. In this country we use zigzag riveting exclusively and each shop is a law to itself on this subject. A safe rule to use for common plates is,

$$Pitch \times 0.7$$

for double and

$$P \times 0.65$$

for triple riveted. In the joint we have discussed this would give the distance as 2 inches and it represents good practice.

"The lap of these joints, ye will remember, will equal the distance from center of rivet hole to edge of plate times 2 plus the distance between the rows. Here is a table of rivet values that covers all sizes an' will save your pencil an' temper. Ye will need to work out various sizes, etc., to be able to answer anny question they may spring on ye."

"I know," replied Duffy; "I'll do it, too, for I want the picture in the frame and the extra money the job will pay. But what does this double shear mean in the rivet table?"

"When ye understand," said Doolin, "the lap joints which are the single shear I'll put ye wise to the butt-strap joints. It will be another story."

RIVET VALUES IN POUNDS PER SQUARE INCH

42,000 LB. SINGLE—78,000 DOUBLE SHEAR

Diameter of Rivet Hole	Area	Shear	
		Single	Double
$\frac{5}{8}'' = 0.5625''$	0.2485″	10,437 lb.	19,383 lb.
$\frac{11}{16}'' = 0.625''$	0.3068″	12,885 lb.	23,930 lb.
$\frac{11}{16}'' = 0.6875''$	0.3712″	15,590 lb.	28,954 lb.
$\frac{3}{4}'' = 0.75''$	0.4417″	18,551 lb.	34,460 lb.
$\frac{13}{16}'' = 0.8125''$	0.5185″	21,777 lb.	40,443 lb.
$\frac{7}{8}'' = 0.875''$	0.6013″	25,254 lb.	46,901 lb.
$\frac{15}{16}'' = 0.9375''$	0.6902″	28,988 lb.	53,843 lb.
$1'' = 1.000''$	0.7854″	32,986 lb.	61,261 lb.
$1\frac{1}{16}'' = 1.0625''$	0.8866″	37,237 lb.	69,155 lb.
$1\frac{1}{8}'' = 1.125''$	0.9940″	41,748 lb.	77,532 lb.
$1\frac{3}{16}'' = 1.1875''$	1.1075″	46,515 lb.	86,385 lb.
$1\frac{1}{4}'' = 1.25''$	1.2271″	51,538 lb.	95,722 lb.
$1\frac{5}{16}'' = 1.3125''$	1.3530″	56,826 lb.	105,534 lb.
$1\frac{3}{8}'' = 1.375''$	1.4849″	60,365 lb.	115,822 lb.
$1\frac{7}{16}'' = 1.4375''$	1.6230″	68,166 lb.	126,594 lb.
$1\frac{1}{2}'' = 1.5''$	1.7671″	74,218 lb.	137,833 lb.

Air Required per Pound of Coal

By Charles M. Rogers

Some reasons tending to show that, as a rule, a high percentage of CO_2 indicates a good furnace efficiency. From the results of actual observations the amount of air per pound of coal is calculated in detail.

Some experts are of the opinion that a high percentage of CO_2 is always accompanied by a correspondingly high loss due to incomplete combustion, that is, the formation of CO. In the writer's opinion this is usually not the case, although in some instances while forcing the fires for the purpose of obtaining a high percentage of CO_2, this holds true. Under ordinary conditions, however, with the stokers running normal, a high percentage of CO_2 is indicative of a high furnace efficiency.

With the usual boiler setting it is difficult to obtain an average CO_2 above 12 or 13 per cent., without considerable loss, due to the formation of CO, unconsumed carbon in the ash, increased weight and temperature of the escaping gases, and the potential energy contained in the unconsumed combustible constituents in the smoke.

Recently, in a certain plant, while the CO_2 recorder was showing good results and the stokers were running normal, a complete analysis of the gases was made and the pounds of air per pound of coal and the loss due to the formation of CO, were calculated. Observations of the flue-gas temperatures in the breeching showed them to be 10.43 per cent. lower with an average of 14 per cent. CO_2 than with an average of 12 per cent., which represents a saving. Further observations showed that the gain due to the reduced weight of the flue gases and likewise increased percentage of CO_2 was balanced by the loss due to incomplete combustion. The accompanying chart shows an autographic record of the percentage of CO_2, and the corresponding draft.

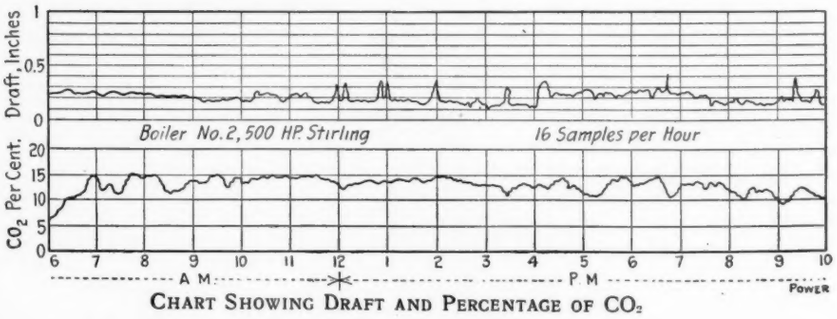


CHART SHOWING DRAFT AND PERCENTAGE OF CO_2

In order to determine the number of cubic feet of air supplied per pound of carbon, it is necessary to determine the total weight of oxygen from the following analysis, and knowing that air contains 23.1 per cent. by weight of oxygen, the air supplied per pound of coal can be readily calculated. In the particular case referred to, an analysis of the gases for four hours showed 14 per cent. of CO_2, 0.68 per cent. of CO and 6.02 per cent. of O. For convenience in figuring, 100 cubic feet of flue gas will be assumed. The respective weights per cubic foot of the component gases are: 0.1234, 0.0781 and 0.0893 pound. Then the total weight of each gas in 100 cubic feet of flue gas are:

CO_2.... $14 \times 0.1234 = 1.7276$ pounds
CO..... $0.68 \times 0.0781 = 0.0531$ pound
O..... $6.02 \times 0.0893 = 0.5376$ pound

The atomic weight of carbon is 12 and of oxygen 16; then a unit of CO_2 contains $\frac{32}{44}$ $\left(\text{equal to } \frac{2 \times 16}{12 + (2 \times 16)}\right)$ part by weight of oxygen and $\frac{12}{44}$ of carbon. Then in 1.7276 pounds of CO_2 there are

$$1.7276 \times \tfrac{32}{44} = 1.2564 \textit{ pounds}$$

of oxygen and

$$1.7276 - 1.2564 = 0.4712 \textit{ pound}$$

of carbon.

In one unit of CO there are $\frac{16}{28}$ $\left(\text{equal to } \frac{16}{12 + 16}\right)$ part by weight of oxygen

and $\frac{12}{28}$ of carbon. Then in 0.0531 pound of CO there are

$$0.0531 \times \tfrac{12}{28} = 0.0303 \textit{ pound}$$

of oxygen and

$$0.0531 - 0.0303 = 0.0228 \textit{ pound}$$

of carbon. In 100 cubic feet of the flue gases there are

$$1.2654 + 0.0303 + 0.5376 = 1.8243 \textit{ pounds}$$

of oxygen and

$$0.4712 + 0.0228 = 0.4940 \textit{ pound}$$

of carbon. There are then 0.4940 pound of carbon for every 1.8243 pounds of oxygen or, for every pound of carbon, there are 3.693 pounds of oxygen. As air contains by weight 23.1 parts of oxygen, this analysis would show that

$$3.693 : 23.1 = X : 100$$

where X represents the weight of air supplied per pound of carbon. This is found to be 15.98 pounds. As the coal contained only 70 per cent. carbon, the weight of air per pound of coal used would be

$$15.98 \times 0.70 = 11.19 \textit{ pounds}$$

The hydrogen and oxygen contents in the coal were not known; hence, a slight error is introduced as the oxygen combines with ⅛ its own weight of hydrogen and forms water. Each remaining pound of hydrogen requires 36 pounds of air for combustion, and is calculated by the formula 36 (H — O/8). This, however, would amount to less than one, and is negligible for practical work. Without knowing the ultimate analysis of the coal it would be somewhat difficult to calculate the heat lost in the escaping gases.

When carbon burns to CO_2 there are 14,650 B.t.u. produced; consequently, when it burns to CO, producing only 4460 B.t.u., there is a loss of 10,190 B.t.u. Then the loss due to the formation of CO is found by multiplying the number of pounds of carbon burned to CO by 10,190 and dividing the product by the calorific value of the coal; that is,

$$\frac{10{,}190 \times 0.0228 \times 100}{12{,}450} = 1.87 \textit{ per cent.}$$

loss, due to the formation of CO.

Then about 16 pounds of air were supplied per pound of carbon, which is an excess of 40 per cent. over the theoretical requirement of 11.54 pounds; and as 40 per cent. excess air is considered good practice, no mistake should be made by firing so as to obtain a CO_2 reading of about 14 per cent., providing the coal is somewhat near the same grade and the furnace equipment is similar to the particular installation considered.

In Munich, peat sells for 380 marks (about $95) for a carload of ten metric tonnes, (about eleven short tons).

Curtis Marine Turbines

In this country great progress has been made in the impulse turbine, especially by the Fore River Shipbuilding Company, of Quincy, Mass., which has devoted itself very largely to the manufacture of the Curtis turbine for war vessels. *The Engineer* in a supplement illustrated two of the latest turbines built by this firm, the smaller turbine being the type employed for a scout cruiser, and the larger that for two new battleships. The accompanying illustrations are reproductions, and the following data are particulars of these vessels:

	Scout Cruiser	Battleship
Number of shafts	3	3
Number of turbines	3	3
Brake horsepower of each turbine	7500	15,000
Revolutions per minute	480	275
Steam pressure, pounds per square inch	250	265
Superheat (deg. Fah.)	0	60
Pitch diameter of turbines, inches	80	132
Number of stages	16	18

In general design these turbines do not differ from each other to any considerable degree. In both turbines there are five moving wheels, the total number of stages being sixteen and eighteen, and the diameters 80 inches and 132 inches respectively, while in each case there are two reverse stages with twelve nozzle openings and four valves; for the ahead turbines there are twenty nozzles, each provided with a valve, these being of the usual sliding type.

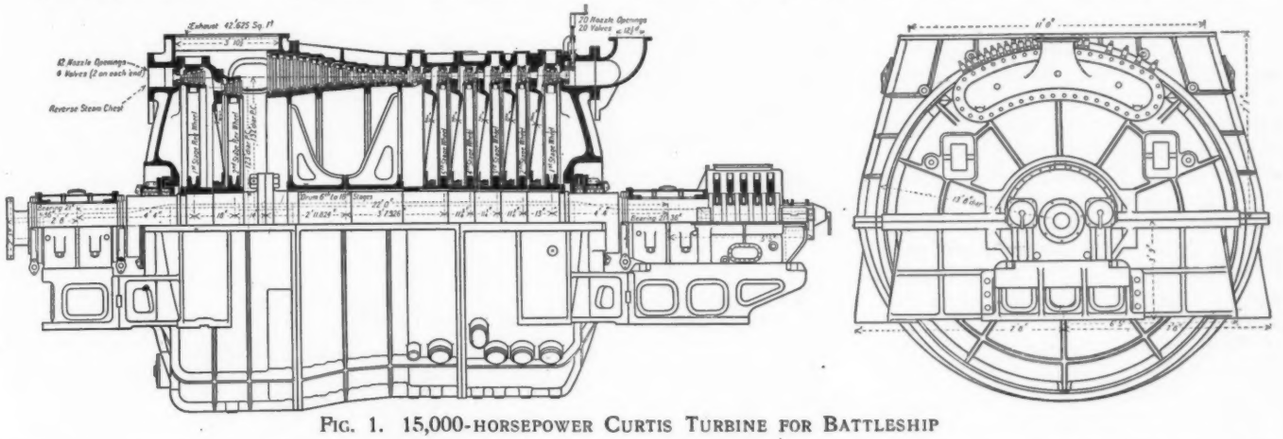


FIG. 1. 15,000-HORSEPOWER CURTIS TURBINE FOR BATTLESHIP

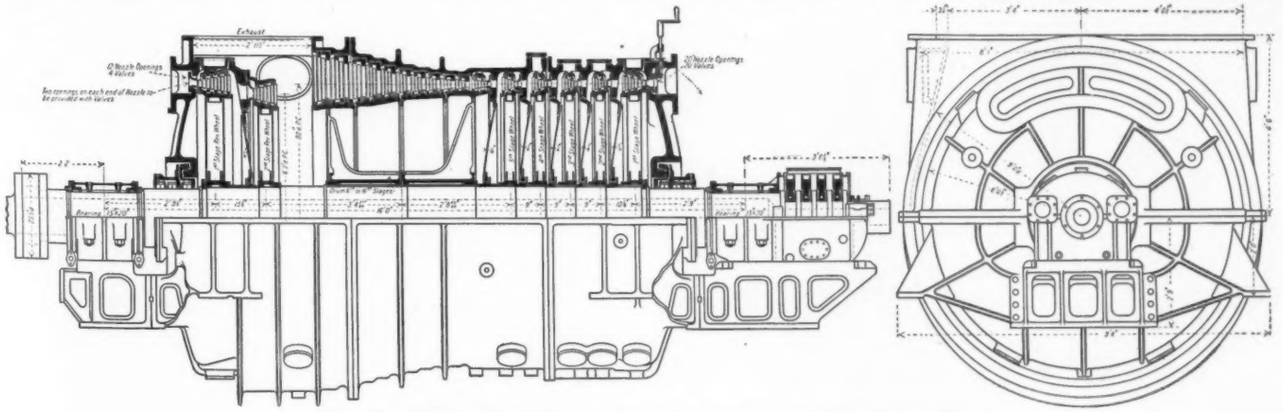


FIG. 2. 7500-HORSEPOWER CURTIS TURBINE FOR SCOUT CRUISER

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Types and Connections of Alternating Current Generators

By Norman G. Meade

Classification of Generators

Alternating-current generators may be divided mechanically into three classes:

Belt-driven machines, entirely self-contained, with two or three bearings, a shaft and a pulley; direct-driven machines, having one or two bearings and a shaft arranged for direct coupling to the prime mover; engine-type alternators, consisting of the field magnet and armature without bearings or shaft, the field magnet being the revolving member and arranged to be mounted on the extended shaft of the steam engine or other prime mover. These three types are illustrated in Figs. 1, 2 and 3, respectively.

Alternators of small capacity are built in two forms, one with a revolving armature and a stationary field magnet and the other with a revolving field magnet and stationary armature. The latter has come into general favor with manufacturers because of its more simple mechanical construction and the greater facility with which the extra insulation necessary for a high-tension armature winding may be provided when the armature is stationary.

Fig. 4 shows the elementary connections of a single-phase revolving-armature alternator and its exciter. The connections of a revolving-field alternator are exactly the same in all essentials, the only distinction being that the low-tension current for the field winding passes through collector rings and brushes, because the magnet revolves, and the high-tension armature current does not, because the armature is stationary. The exciting current for the field winding of any standard alternator may be supplied from any constant-potential direct-current circuit of about 125 volts.

Electrically, alternators may be also divided into three types: Single-phase,

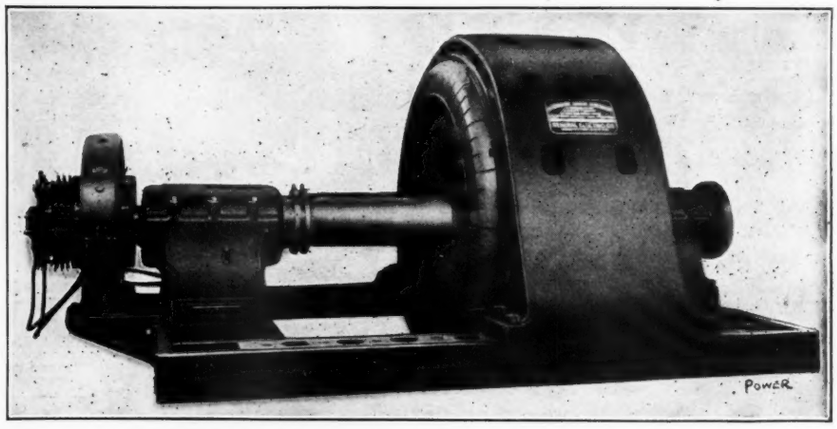


Fig. 2. Alternator for Direct Coupling

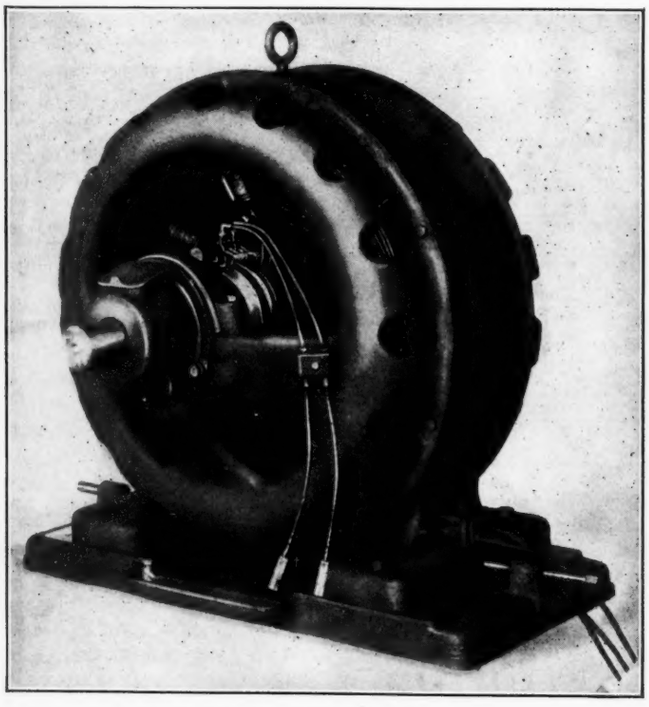


Fig. 1. Alternator for Belt Drive

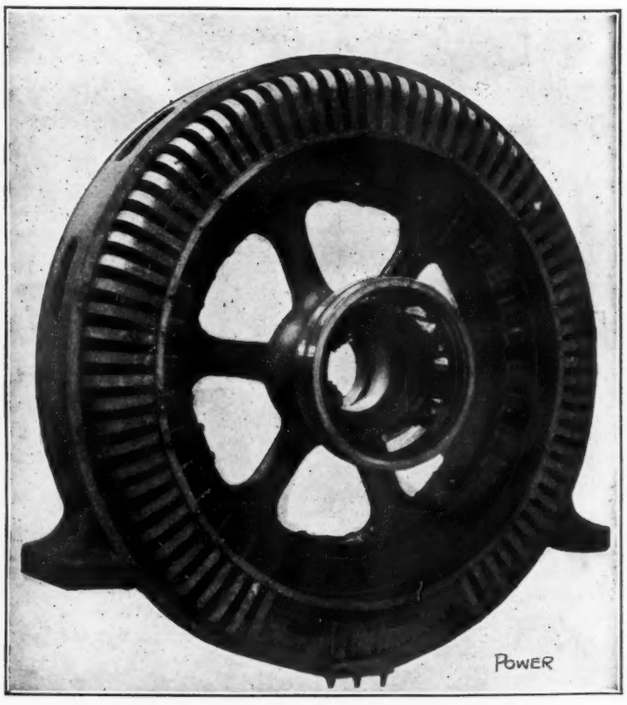


Fig. 3. Alternator for Diregt Mounting

two-phase and three-phase. There was formerly a fourth type designated the "monocyclic," but that is no longer manufactured. Fig. 5 is a schematic diagram of a single-phase armature winding for

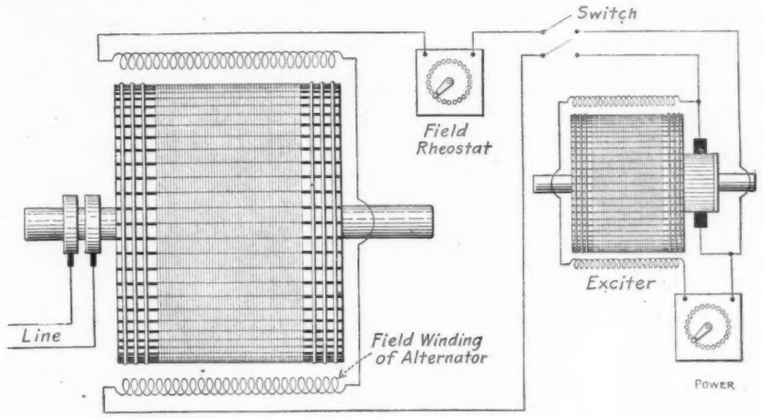


FIG. 4. CONNECTIONS OF SINGLE-PHASE ALTERNATOR AND ITS EXCITER

an alternator having six field-magnet poles. As alternators are generally designed to deliver a high voltage the coils are connected all in series and the two ends are connected to two collector rings

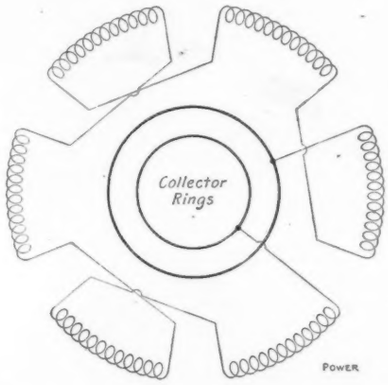


FIG. 5. SINGLE-PHASE SIX-COIL ARMATURE WINDING

on the revolving-armature type of machine, as here shown, or to terminal blocks or leads on the revolving-field type of machine.

Fig. 6 is a diagram of the most common type of two-phase winding, which comprises two distinct circuits. The windings, indicated by A and B, are connected respectively to the external circuit-wires A_1, B_2 and B_1, B_2. The windings have no electrical connection with each other and the circuits are also distinct. The circuit A_1, A_2 constitutes one "phase" or division of the general system and the circuit B_1, B_2, the other. In some instances, instead of using two separate circuits with four terminal connections, as shown in Fig. 6, a common return wire is employed as shown at C in Fig. 7. This arrangement is seldom used in modern plants.

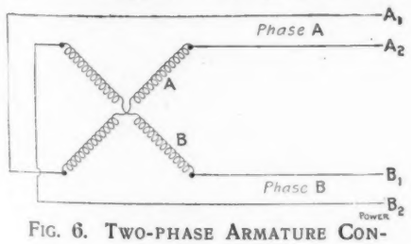


FIG. 6. TWO-PHASE ARMATURE CONNECTIONS

The three-phase alternator furnishes three electromotive forces differing in phase by 120 degrees or one-third of a complete cycle. This is accomplished by providing the armature with three windings displaced 120 degrees from each other. There are two general types of windings, designated as the "star" or "Y" and the "mesh" or "delta"; these are represented diagrammatically in Figs. 8 and 9, respectively. In the star or Y winding the three separate sets of coils composing it are connected at one terminal each to a common junction which forms the neutral point of the winding and the three free ends are connected to the line wires. The connections of the delta winding are evident in Fig. 9.

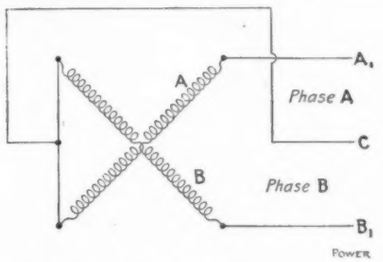


FIG. 7. TWO-PHASE CONNECTION FOR COMMON RETURN

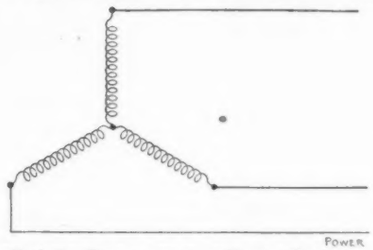


FIG. 8. THREE-PHASE STAR CONNECTION

The monocyclic alternator was built for use in stations where the greater part of the load consists of electric lights but where it is desired to supply current also to a number of induction motors. It is really a single-phase machine with an auxiliary armature winding which is used only to supply current for starting motors.

Fig. 10 shows the connections of a monocyclic generator and Fig. 11 shows the arrangement of the coils on the armature core. The larger coil indicates the main winding and the smaller one the auxiliary winding, which is commonly called the "teaser" winding. In the diagram, Fig. 10, the electromotive force of the generator has been put at 2080 volts and the various voltages indicated correspond to this potential. If the machine were wound for the more modern voltage of 2300, the teaser winding would give 575 volts.

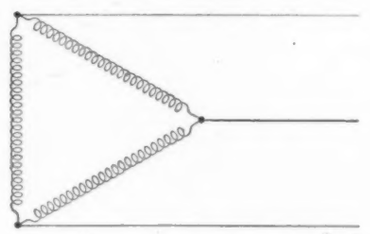


FIG. 9. THREE-PHASE DELTA CONNECTION

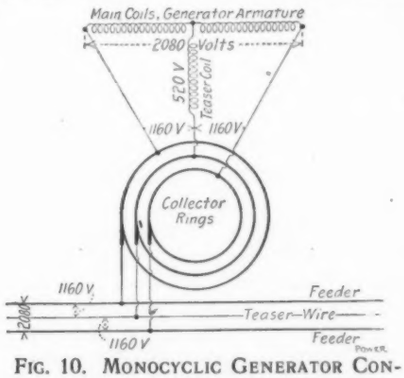


FIG. 10. MONOCYCLIC GENERATOR CONNECTIONS

As there are two main terminals and the teaser terminal, three collector rings are provided, as shown. Between each end of the main winding and the end of the teaser winding there is a resultant electromotive force which is nearly 12 per cent. larger than one-half of

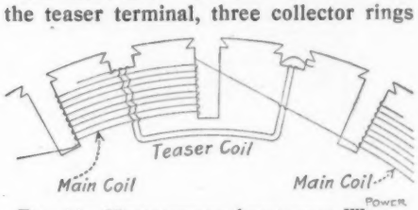


FIG. 11. MONOCYCLIC ARMATURE WINDING

the main electromotive force, as indicated by the voltage figures. This e.m.f. also differs in phase from the main e.m.f. and it is this feature which enables an induction motor to start automatically when supplied from a monocyclic alternator.

Small single-phase generators are usually provided with compensating field windings by means of which the field excitation is made to vary automatically in proportion to the load and thereby compensate for the voltage drop in the armature winding. The field magnet is equipped with two windings similar to those used on compound-wound direct-current generators. The main winding is supplied with direct current from the exciter and the other winding is supplied with rectified current from the armature of the alternator, causing the excitation of the field magnet to increase when the load increases. The current flowing through the compensating winding is rectified by a commutator and is reduced to the proper voltage by means of a series transformer.

Fig. 12 shows the connections of a single-phase alternator with a compensating winding, and Figs. 13 and 14 show respectively the corresponding connections of a two-phase and a three-phase alternator.

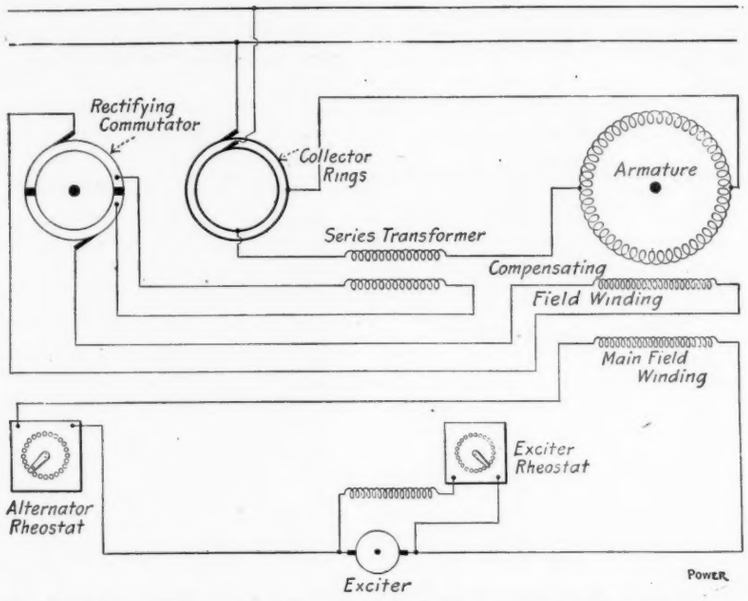


FIG. 12. COMPLETE CIRCUITS OF SINGLE-PHASE COMPENSATED ALTERNATOR AND ITS EXCITER

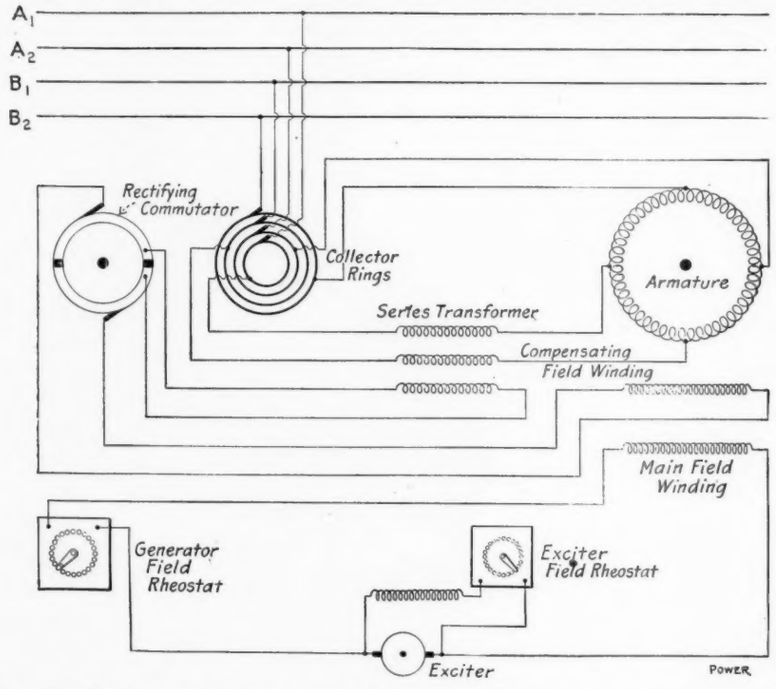


FIG. 13. COMPLETE CIRCUITS OF TWO-PHASE COMPENSATED ALTERNATOR AND ITS EXCITER

SWITCHBOARD CONNECTIONS OF A SINGLE GENERATOR

Figs. 15, 16 and 17 are diagrams of the connections of single-phase, two-phase and three-phase alternators, respectively. The usual switchboard accessories of a single-phase machine, as indicated in Fig. 15, consist of a pair of fuses or a circuit-breaker, an ammeter,

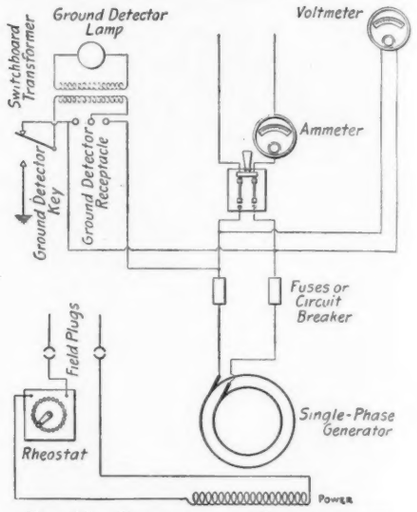


FIG. 15. CIRCUITS AND SWITCHBOARD CONNECTIONS OF SINGLE-PHASE ALTERNATOR

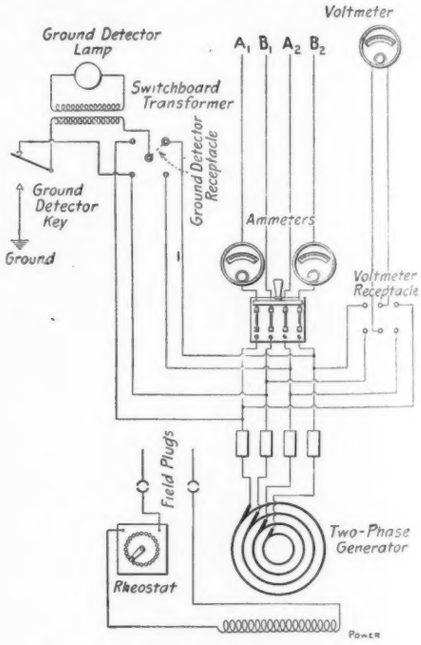


FIG. 16. CIRCUITS AND SWITCHBOARD CONNECTIONS OF TWO-PHASE ALTERNATOR

a voltmeter, a ground detector and its plug receptacle, a field rheostat and field-connecting plugs and sockets; the exciter is connected to the generator field winding by means of these plugs and sockets.

For low-tension generators of about 600 volts and under, a lamp supplied through a transformer is used to indicate grounds. The ground-detector receptacle is provided with three holes and by means of

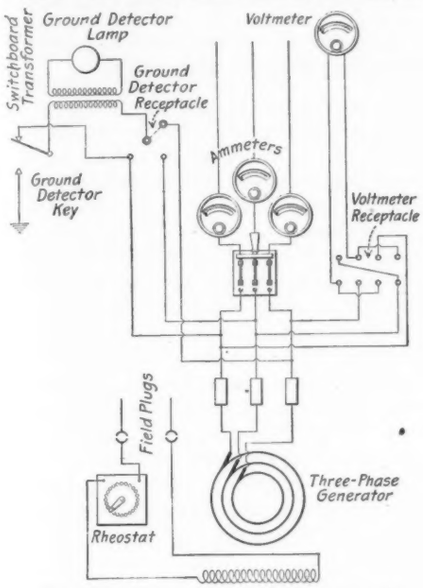


FIG. 17. CIRCUITS AND SWITCHBOARD CONNECTIONS OF THREE-PHASE ALTERNATOR

a double plug the lamp can be connected to either side of the circuit by inserting it in the left-hand and center holes or in the right-hand and center holes. The detector key is depressed when the plug is in one of the two positions and if there be a ground it is then indicated by the burning of the lamp.

Fig. 16 shows the switchboard connections of a two-phase low-voltage alternator. With this type of machine two ammeters are necessary, one for each phase. By means of the voltmeter receptacle a single voltmeter may be connected to either phase; with the plug in the center and right-hand holes it is connected to phase *A*. The ground-detector receptacle is constructed so that the ground-detector lamp can be connected to either wire of either phase.

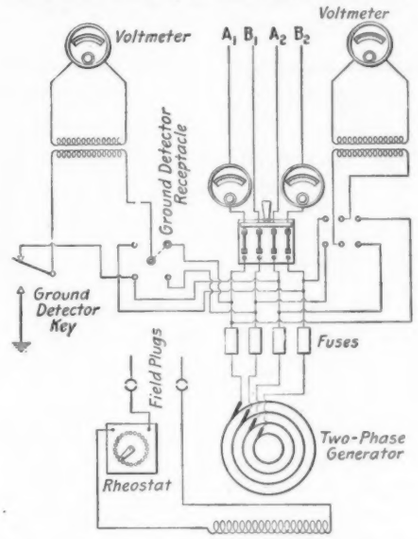


FIG. 18. CIRCUITS AND CONNECTIONS OF HIGH-TENSION TWO-PHASE ALTERNATOR

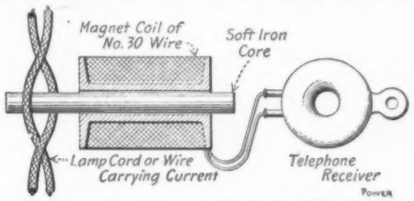
The connections of a low-voltage three-phase alternator are shown in Fig. 17. The connections are similar to those of the two-phase generator with the exception that three ammeters are necessary, one for each phase, and the voltmeter and ground-detector receptacles are arranged a little differently to allow connection to either one of three phases instead of either one of two only.

Fig. 18 shows the switchboard connections of a high-voltage two-phase alternator, which differ from those in Fig. 16 only in that a voltmeter is used instead of a lamp for indicating grounds and the main voltmeter is connected to the alternator leads through a transformer instead of by a direct metallic circuit.

LETTERS

Identification of Alternating and Direct Current

The device shown in the accompanying drawing is of much convenience, not only in testing house wiring but in conduit and line work. One of the many uses to



ARRANGEMENT OF TESTING DEVICE

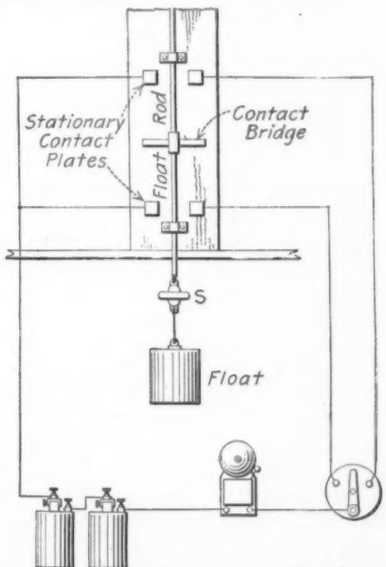
which it can be put is the distinction of alternating and direct currents, which has been the subject of considerable discussion in this department. If the soft-iron core be brought near a wire in which an alternating current is flowing, a loud hum will be heard in the telephone receiver; in the case of a direct-current circuit, the only indication will be a click when the circuit is closed or broken.

R. S. SEESE.

Urbana, Ill.

Mr. Dolphin's Signal System

In Mr. Dolphin's description of a water-tank signal system, which appeared on page 733 of the May 9 issue, the diagram of connections contained an error. The two wires leading up from the two-way switch to the float contacts were shown connected by a "jumper." The correct diagram is shown herewith.



CORRECT DIAGRAM OF MR. DOLPHIN'S CIRCUITS

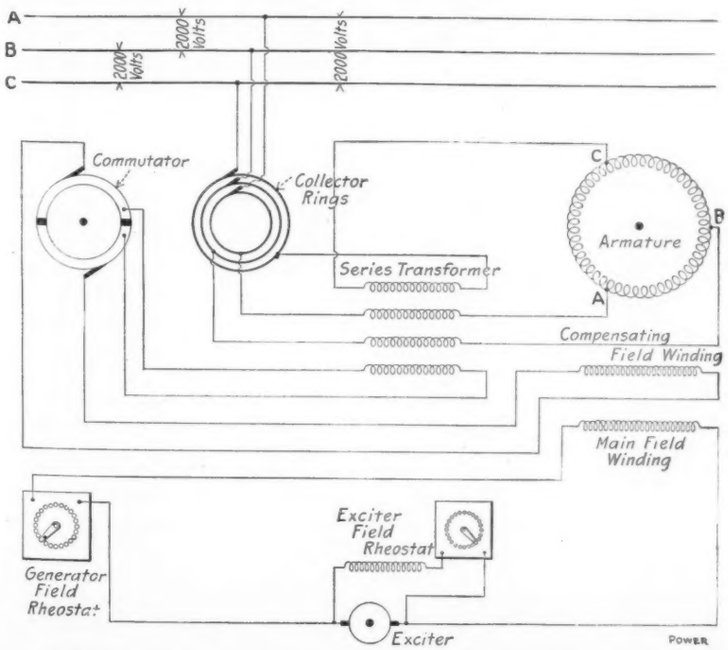


FIG. 14. COMPLETE CIRCUITS OF THREE-PHASE COMPENSATED ALTERNATOR AND ITS EXCITER

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Peat Gas Power in Germany

By F. E. Junge

Scarcity of resources and density of population force the German engineer to reduce to the utmost the cost of power in industrial production. In most German industries the power cost is an important item in the total cost of manufacture and, unlike wages and interest rates, it can be lowered by scientific endeavor without harming the income of either capitalists or workmen.

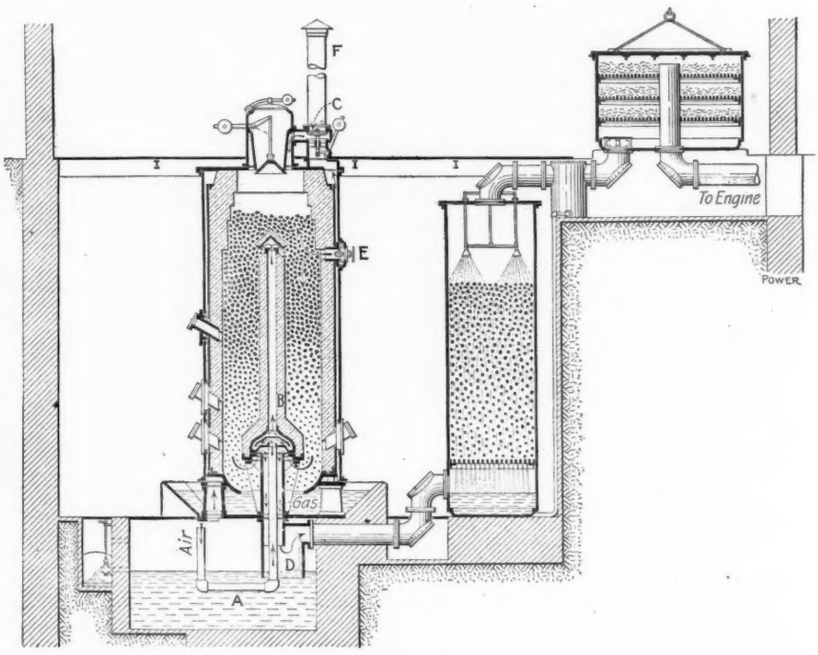
Fuel Supply

While there is a sufficiency of high-grade coals, like anthracite, bituminous and lignite, in the country, it has been found more profitable to use these fuels wherever possible at the mouth of the pit than to transport them by rail or canal to the power houses. In combined iron- and steel-smelting plants and coal mines, for instance, gasification in coke ovens and producers is most practicable, the coke and gas produced being utilized in the furnaces of the plant, the valuable byproducts, tar, benzol and ammonium, being marketed while the surplus available energy is distributed by high-tension electrical systems to neighboring industries, cities and agricultural districts.

Unfortunately, the German coalfields are not distributed symmetrically over the whole country; they are located partly in the extreme east and partly in the extreme west. Consequently, industries which are located in the middle or northern regions suffer from the natural discrimination by lack of cheap sources of power. This disadvantage is being gradually overcome, at least in some sections of the country, by utilizing the peat bogs, which are abundant, for the generation of power.

These bogs have an average depth of 3 meters (9.8 feet). Assuming that one cubic meter of raw peat yields about 150 kilograms (330 pounds) of dry peat, the quantity of dry peat available in Prussia for purposes of power production can be estimated at some eleven billion tons. In Germany, labor is comparatively cheap and reliable. Hence, when installing a power plant we can figure on fetching the raw peat by hand from the field and transporting it by rail or cableway to the power house, which is built in the immediate vicinity of the bog and located below the surface level so that the peat can be dumped from the cart or bucket right into the producer.

One laborer with an average pay of 75 cents a day supplies about 1800 kilograms (3960 pounds) of dry peat per day, 1 kilogram (2.2 pounds) costing about one-twenty-fifth of one cent. For purposes of large-scale power generation, automatic dredges are employed. Such a machine weighs about 3000 kilograms (6600 pounds), is run by one attendant and produces 6 tons of dry peat per hour. The detail cost of operation is 3.5 cents for fuel (benzol), 0.25 of a cent for lubricant, 1 cent for wages, making the total 5 cents per ton of peat turned out. This obviously does not include interest, amortization and repairs to the dredging machine. The capital invested in peat bogs need not be amortized because in most cases good fertile soil is laid open to the plow, whereby the value of the land increases.



The Heinz Peat Gas Producer

Utilization of Peat

There are various processes which enable one to utilize not only the peat gas but a number of valuable byproducts besides. Thus the Woltereck process provides for the utilization of ammonium, which is produced in considerable quantities when a mixture of air and steam is passed above a stratum of carbon. Frank and Caro, having adopted an improved Mond process, utilize not only the byproducts but also part (15.5 per cent.) of the potential heat energy of the peat. Ziegler makes coke, gas and byproducts in special peat-coke ovens. But it is obvious that all these processes, interesting though they are, are rather complicated, requiring both mechanical and chemical skill and making the enterprise often unprofitable, especially when markets for the disposal of byproducts are not at hand. The direct combustion of peat on special grates under steam boilers has also not proved a complete success, because, in most cases, ordinary steam coal must be mixed with the peat in order to evolve the necessary heat.

By far the greatest practical success has been attained with the direct gasification of raw, air-dried peat in producers, the gas being used for the development of power in gas engines and no utilization of byproducts being attempted. Being both porous and light, peat is by nature well suited for gasification in producers. These qualities permit a deep bed of fuel to be used

which, in turn, offers a large surface to the air, whereby the oxygen finds ample opportunity to unite with the carbon of the peat. The chief difficulty is, of course, to dispose of the tar-forming constituents and of the high moisture contained in the peat and the only practical way so far developed is to eliminate both within the generator itself. To attain this some producer designers employ two zones of combustion, the same as when using lignite, the gas produced being usually withdrawn from the middle, between the two zones. Some of them draw the gas which is produced in the upper zone through a bypass into the lower zone, the gas being cooled on its way down and the water vapor condensed. Naturally there is some heat lost by this cooling and, furthermore, it is difficult to maintain combustion in the upper zone when the fuel is very wet, because the heat liberated by the combustion below does not materially assist the combustion above.

Peat, being a very poor conductor of heat, does not yield its moisture contents easily by mere warming up. It has been observed in practice that frozen lumps of peat after being for three hours in the combustion zone of the generator, where they were subject to a temperature of some 3000 degrees Centigrade, when taken out were incandescent on the outside but still frozen within, there being a zone of moisture between the outer layers and the kernel.

Another mistake which was made in the construction of peat producers consisted in arranging so that the gas was taken out from the side of the generator wall. There the fuel is generally looser than in the center of the bed; hence, the resistance offered by the fuel to the passage of air is less and combustion livelier, whereby hollow spaces burn out near the wall, through which the air entering below may escape into the delivery pipe without doing any useful service. This leads to operative difficulties.

Finally, there is the difficulty with double-zone peat gas generators that the amount of air admitted to the two zones at various loads cannot be balanced. It is obvious that there must be a fixed ratio between the air entering above and the air entering below, if the composition of the gas during operation is to remain the same. But the flow of air depends on the resistance offered to its passage by the fuel column, and this resistance changes constantly and not proportionally in the two zones; consequently, at one time relatively more air enters from above than below and at another time more from below. If the load on the engine should drop from full to quarter load, the suction effect of the engine in the gas generator will be very low and the air will enter through the path of least resistance, which may be either above or below, depending on the momentary composition of the fuel beds. There is no certainty of operation and the output of the producer remains in practice often far below its rated capacity.

The Heinz Producer

All of the difficulties mentioned appear to have been overcome in a peat producer designed by Carl Heinz for the Görlitzer Maschinenfabrik, in Görlitz, Silesia, which seems to afford the most satisfactory method of utilizing peat for the purpose of power development. Unlike the double-zone type, the air enters above and the gas is withdrawn from the center of the combustion chamber below. Gasification of the fuel takes place in one direction only, and the air, instead of traveling along the walls of the generator, is forced to enter the inner strata of the fuel bed. The heavy gases produced in the upper layers of the fuel bed are forced to pass through the incandescent zone below, where they are split up and converted into light and permanent gases.

Another feature of the Heinz producer consists in the complete utilization of the heat generated in the processes of gasification. The accompanying illustration is a vertical section of the complete producer. All of the air for the generator is taken from the pit beneath it, which also contains the scrubber water and the gas-delivery pipe *D*. Part of the air is drawn through the pipe *A* and the superheater *B* into the upper part of the fuel column, whence it must travel down through the fuel bed in order to reach the gas outlet below. The remainder of the air ascends through the space between the outer and the inner shells of the generator, absorbing radiant heat, and under normal conditions it enters, through the valve *C* at the base of the purge pipe *F*, the combustion chamber above the fuel bed. The outer shell usually does not become warmer than the surrounding atmosphere, and the delivery pipe entering the scrubber is only moderately heated, indicating unmistakably that almost all of the heat which is usually lost through convection and radiation is utilized in the generating process.

If the water content of the peat exceeds certain limits, somewhere around 40 per cent., an auxiliary process is employed temporarily by starting a second combustion zone near the top of the fuel bed. This is done, by opening the pipe *F* and the auxiliary air-inlet valve *E*, as soon as the attendant notes that the fire on top of the fuel column is disappearing. The valve *C* then closes automatically and the air which is preheated in the space between the shells enters the fuel bed directly through the valve *E*. Thus combustion is started at the level of *E* both ways, the up-draft being provided by the pipe *F* serving as a chimney and the down-draft by the suction of the engine. As soon as incandescence is reëstablished on top of the fuel bed the purge pipe *F* is closed off and the valve *E* shut; the normal process is thereby resumed. By the temporary employment of this expedient, fuels of very high water content can be gasified. Of course, there is a moisture limit, for in peat containing 80 per cent. of water the 20 per cent. of combustible would be only sufficient to vaporize the water and no combustible gas could be produced. With the auxiliary process the consumption of fuel per horsepower-hour becomes somewhat greater than normal, but the operation is very simple and free from troubles.

In this producer all the gases emanating from the scrubber water are drawn up with the air into the combustion chamber and destroyed. The gas produced is very clean. With continuous day and night operation cleaning of the engine is necessary only once every three months, there being only a slight coating of sediment on the interior surfaces. The removal of slag and ashes can be done at any time during operation.

Air-dried peat, under conditions as they are in Germany, can be had for an average price of 25 cents on the bog. The consumption of peat containing 40 per cent. of moisture varies between 1.9 and 2.7 pounds and that of air-dried peat between 1.29 and 1.62 pounds per brake horsepower-hour, according to the composition of the fuel and the load on the engine. The efficiency of the generator alone is about 92 per cent. and that of the complete plant about 86.5 per cent.

CORRESPONDENCE

Make and Break Ignition Troubles

Under this heading in the April 18 issue of POWER, Mr. Kirlin refers to igniter troubles and gives particulars of tests for locating them. Operating engineers will find scant need for these tests if they will remove their make-and-break igniters, say, twice a week, not necessarily for filing up or adjustment but just to see that conditions are all right, that the points are not badly worn and pitted and that serious corrosion has not taken place. Waiting until trouble comes and then applying Mr. Kirlin's tests would savor rather of laziness. It is no great trouble to occasionally unscrew the two nuts which usually hold the igniter in place; the wiring need not be disconnected at all if the igniter is all right. The foregoing applies to high-tension jump-spark plugs as well as to make-and-break igniters.

Prevention is better than cure in the engine room just as truly as in considerations of personal health.

JOHN S. LEESE.

Manchester, Eng.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Filing Clippings

Although most of the articles appearing in POWER will be found to be interesting, few will be of such a nature that the average man will want to keep them, for what interests one man, another already knows.

If the card index of the articles kept for reference is used, a good plan is to give not only the title of the article but also information regarding the text.

I have been clipping articles and filing them for the last ten years and, after trying out all other ways, I believe this to be the best.

In order to keep the articles upon different subjects separate from each other they should be placed in heavy manila-paper folders, which should not be folded exactly in the middle, but so that one side will project ½ inch above the other side. This will furnish space upon which to write the title or number of the file. The best way is to use numbers and to have one number placed in each corner of the folder. By means of an alphabetical index written on a sheet or sheets of paper and kept in the file it will be easy to find the proper folder at any time, as this index will give the number of the folder as well as the type of the articles to be found in it.

Instead of filing the folders alphabetically a better plan is to place all of those referring to closely related subjects together. As an example, all of the articles referring to engines, although they might be in several folders, would be so placed that the folders containing them would follow each other. Then there should be several numbers left vacant so that if other folders containing matter on engines, but not contained in any of the first folders, are added later there will be space for them at the proper place. After the space left for added folders there should be several folders covering boilers and their various parts. The file should be made up in this way until all of the subjects have been covered.

In order to be able to turn quickly to the right folder without having to turn over a number of them before reaching the right one it is well to have what are known as guide cards. These are made of stiff paper and are placed between each ten folders. They should project about ⅜ inch above the folders and this ⅜ inch should be cut away for four-fifths of the distance across the tops. The projecting tabs, after the rest has been cut away, should be staggered so that they will not be directly behind each other but each will be one-fifth of the distance across the top to the side of the one in front. Then the guide cards numbered 10 and 60 will be directly behind each other, as will 20 and 70, and so on.

G. H. MCKELWAY.

Brooklyn, N. Y.

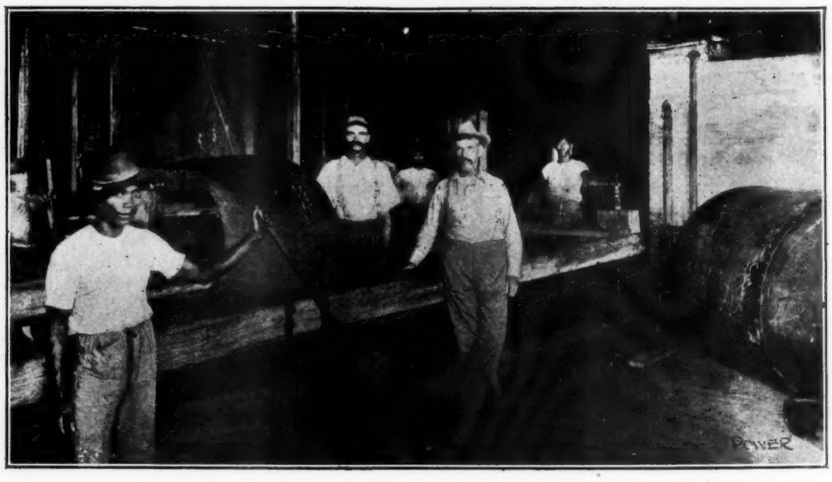
Making Smokestacks in Manila

The accompanying photograph shows how two smokestacks were rolled on three rollers made out of old pipe. One was a 58-inch stack for a crematory and the other was an 11-inch stack for a road roller. One of the pipe rollers is not shown in the photograph. Any old pipe and timber which happens to be on hand answers. The rolls are adjusted by turning the nuts on the bolts that pass up through the four corners of the frame with monkey wrenches in the hands of the two natives.

A part of the 58-inch stack is shown, but the 11-inch stack was sent out before the photograph was taken. The rollers are easily turned by means of a chain pipe wrench. A piece of strap iron is placed between the pipe and timbers.

J. M. G. TONEY.

Manila, P. I.



HOW SMOKE STACKS ARE MADE IN MANILA

Air Compressor Lubrication

Having noted that considerable interest is being taken in the subject of lubrication by readers of POWER, I am giving the accompanying data which may be of interest. It is a report of the use of lubricating oils in the three air-compressor plants of the Isthmian Canal Commission for the month of February, 1911. It shows the number of revolutions, square feet covered per pint of oil, output in cubic feet of air and the cost per million square feet covered.

Oils Used:	Empire Air Compressor	Las Cascadas Air Compressor	Rio Grande Air Compressor
Valve oil	87¾ gal.	22 gal.	38 gal.
Stationary-engine oil	157¾ gal.	35 gal.	60 gal.
Air-compressor cylinder oil	87¾ gal.	23 gal.	45 gal.
Revolutions per gallon of valve oil:	236,458	295,655	217,650
Revolutions per gallon of stationary-engine oil:	131,532	185,840	137,845
Revolutions per gallon of air-compressor cylinder oil:	236,458	282,800	183,682
Square feet covered per pint of valve oil:	1,041,107	1,392,597	1,025,122
Square feet covered per pint of air-compressor cylinder oil:	1,354,971	1,837,513	1,028,152
Cost per million square feet covered (surface):			
Valve oil	$0.0234	$0.0175	$0.0237
Air-compressor cylinder	$0.0134	$0.0098	$0.0176
Output of free air, cubic feet:	378,879,661	118,770,526	151,205,582

In the air-compressor plants at Empire, Las Cascadas and Rio Grande, there are 14 compressors, each of 425 horsepower and all operating at a steam pressure of 125 pounds. The engines are simple twin cylinder. The compressors are of the double-cylinder cross-compound type. The area of the two steam cylinders is 9.42 square feet; the area of the low-pressure air cylinders is 15.17; the area of the high-pressure cylinders is 9.42 square feet. The speed of these compressors is from 127 to 137 revolutions per minute.

D. E. IRWIN.

Empire, Panama.

Adjusting Cutoff of Corliss Engine

When about to adjust the cutoff of a Corliss engine, of the short-range cutoff gear, start the engine running very slowly and loosen the check nuts on the reach rod, and see that the governor is down on the stops. Then lengthen the rod until the knockoff cam starts to disengage the valve stem; screw the rod out until the knockoff cam will not disengage the hook; or, in other words, until the engine carries the valve. After setting the first cutoff cam set the head-end cam in the same way.

In the case of a long-range cutoff gear, shorten the reach rod until it carries the valve and then lengthen the rod until it will just disengage the hook. Then adjust the knockoff on the second valve or one on the head-end in the same manner.

All Corliss engines with short-range cutoff gears should carry the valves without disengaging when running slowly. A Corliss engine with a long-range cutoff should disengage the hooks at all times; if not, the steam will blow through the engine.

W. R. BOWERS.

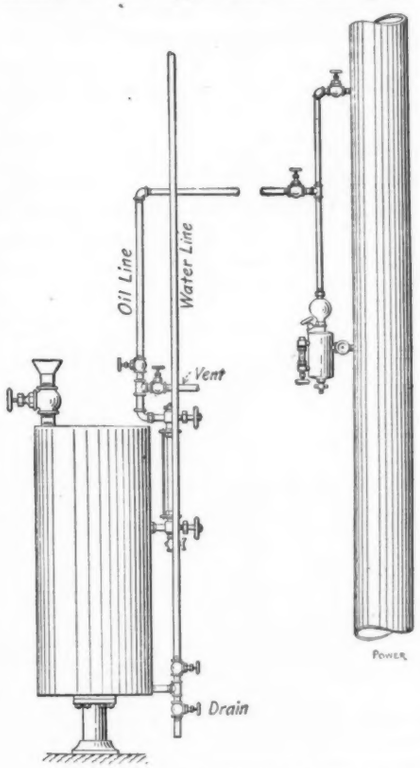
Cleveland, O.

Homemade Lubricating System

The accompanying illustration shows a gravity system for cylinder-oil distribution which works better than any system I have yet tried.

The oil tank is made of a piece of 10-inch pipe, 2 feet or more in length, with the ends capped. On the bottom there is a 2-inch pipe flange fastened by cap screws and into this is screwed a piece of 2-inch pipe about 2 feet long. The bottom flange serves for a floor stand for the tank.

At the bottom of the tank a hole is drilled and tapped for a ½-inch nipple with a tee on the end. A nipple and valve is screwed into the lower end of the tee to serve as a drain. Into the upper end of the tee a short nipple with a valve is screwed and to this the water-condensing pipe is attached, which is connected to a steam pipe. This condensing pipe must not be less than 2 feet above the highest point to which oil is to be delivered. In case the boilers are below the engine level run the pipe up above the highest point of oil delivery and then down to the tank; the cap on the top of the tank should have one ¾-inch and one 1¼-inch drilled hole. The larger hole is to be used for filling. It is better to have a short piece of pipe with a valve screwed into this hole, but a plug may be used instead. The ¾-inch hole should have a short nipple screwed in and a ¾ and ½ by ¾-inch tee screwed securely to the side opening of the tee which is attached to the upper end of the gage



HOMEMADE LUBRICATING SYSTEM

glass. The lower end is tapped into the side of the tank. Twelve inches below the top of the tee, attach a ½-inch tee with a close nipple and to the side opening of this tee attach a ½-inch valve or pet cock for a vent, when filling the tank. From the top opening of the tee attach a ½-inch valve with a short nipple and run the pipe from this valve to the engine or pump lubricators in as direct a line as possible, reducing to ¼ inch for branch lines.

In case of single-connection lubricators, the oil line should be attached to the bottom of the lubricator where the drain comes out, by using a close nipple, tee and pet cock.

To start the system, fill the tank full of oil, close the valves in the drains, vent and oil line and open the valve in the water line, allowing it to fill with condensed water to its highest point. Have all valves in the branch lines closed and then open the valve in the oil line at the tank and loosen a union at the most distant point to allow air to escape very slowly, until oil shows. Then make the joint tight. The various lubricators are then ready to feed.

A. H. STRONG.

Los Angeles, Cal.

A Successful Municipal Electric Plant

It has been said by many that municipal ownership is a failure. This is true in some cases, but not in all. I believe that when a municipal electric light and water works fails to produce a revenue for the city, the cause is due to either mismanagement or graft and possibly both.

That one municipality owns and operates water and light plants successfully is shown by the figures given herewith.

After years, with an annual expenditure of $5000 for city lights, while the citizens were burdened with the rate of 50 cents a light, or 15 cents per kilowatt-hour, the council purchased the plant from the private corporation for the sum of $14,500 and ran it under municipal rule for about a year, when it was found that the equipment and capacity were entirely inadequate for the needs of the city—the electrical units consisting of one 75-kilowatt direct-current generator and one 30-light arc machine.

Therefore a new plant was built which consists of two high-pressure boilers and two 16x15-inch four-valve engines which run at 225 revolutions per minute. Ten dollars covers the cost of the repairs on both engines since they were put in operation three years ago. Two 150-kilovolt-ampere alternators with two 9-kilowatt exciters and a switchboard were also installed. Current is produced for 2 cents per kilowatt-hour. This includes the salaries of two engineers, two firemen and the cost of unloading the coal.

Current is furnished for the waterworks plant two miles distant. The waterworks units consist of one 125-horsepower motor direct connected to a three-stage centrifugal pump.

A close record is kept at the electric plant of the coal, oil, grease, water and packing and other supplies used. The amounts used are put down on the daily station report. All meters are read daily and the readings are kept on the daily station report. The total outfit, including the erection of the building, cost approximately $38,000.

As soon as the new plant was put into operation a continuous service was established which has given the people the advantages of both the day and night service, while formerly, under the old plan, only night service was available.

All rates were put on the meter scale of 12 cents per kilowatt-hour, and, after

the erection of the new plant, this cost was further reduced by the establishment of a sliding scale which ran from 12 cents per kilowatt-hour down to 8 cents, according to the amount consumed.

Under municipal rule, and in spite of the reduced rates for power, the plant has netted the city a good profit. Besides taking care of the indebtedness of a few thousand dollars, incurred at the time the new plant was erected, keeping up the necessary repairs to the machinery, paying salaries of the employees and other necessary incidental expenses, the commission now has on deposit the sum of $10,000, which, although a portion came from the water works, was largely made up from the revenues of the electric-light plant.

I believe this plant is doing as well as most of the privately owned plants and better than most of the municipally owned plants.

H. B. ADCOCK.

Newnan, Ga.

No Water—Burnt Sheet

The following paragraphs tell about what might have been a disastrous boiler explosion had the boiler in question been cut in on the header at the time of the accident. The boiler is one of seven, all of which were connected into one common header.

This boiler was washed out on a Sunday and was filled with water to the second gage cock and left for the night fireman to steam up and cut in on the header for work Monday morning.

The boiler was fired about 2 o'clock a.m. When the day crew came on duty at 6 o'clock a.m., one of the firemen noticed that the boiler had only 75 pounds pressure and opening the fire door to put in a fire discovered that the sheet over the fire was red hot. He closed the door and had gotten about 10 feet away when the rupture occurred.

The boiler exhausted itself of what steam and water there was in it in about four minutes. It was then noticed that there was still two gages of water in the glass, and upon investigation it was found that the bottom water-column connection was closed. The ruptured sheet was down 8 inches and the diameter of the bag was about 10 inches. The opening in the sheet was 6 inches long and the metal was drawn until the thickness at this point was but 1/16 inch thick.

The fact that this boiler was not cut in is perhaps all that prevented a disastrous explosion. The safety column was a hindrance as the water in the column sustained the float and kept the pressure on the controller-valve diaphragm which prevented the cold water being pumped in on the hot sheet.

I write this letter merely to show how some of the so called mysterious boiler explosions occur. If this boiler had exploded violently, anyone who might have seen it five minutes before the accident could have sworn that there was but 75 pounds of pressure indicated by the gage and two gages of water at the time. In reality there was 75 pounds pressure and practically no water.

H. R. ROCKWELL.

Alton, Ill.

Worn Governor Links Cause Trouble

At the plant where I am employed, a new, medium-speed cross-compound engine of an uptodate make was installed. When I indicated the engine I got a card that showed an unequal distribution of the load. I made adjustments but found that when I got the cutoff equal on both ends, I had interfered with the lead. As I believe that proper lead is more important than equal cutoff I put the valves back where I found them.

The governor of this engine is fastened to the shaft by means of setscrews set into the holes in the shaft. If one wishes to move the governor it would be necessary to move the hub an inch or more in order to find a new place for the screw and this would set the eccentric too far ahead or behind to give the proper lead.

After this engine had been running about a year it would speed up when the load was thrown off. It finally got to racing so badly that I would have to cut out the condenser in order to prevent a dangerous speed.

I located the trouble in the governor-link bearings which connected the weight to the eccentric. They were badly worn. The stud pins on which the link worked are of brass, but the link is made of wrought iron. This wearing allowed the weights to move out to their farthest position without carrying the eccentric with them, thus allowing the valves to open a small amount. This, combined with a 27-inch vacuum, caused the engine to race. I put in new links and this stopped the trouble.

A. W. GRISWOLD.

Adams, Mass.

Faulty Piping and Carelessness Wreck Engine

The Corliss engine in a mill plant became overloaded and a new high-speed engine was set up to take care of the lighting load.

Not wishing to install an extra condenser or to exhaust to the atmosphere, it was decided to connect the exhaust as shown in the illustration. The engineer wished to connect the engine direct to the condenser, but the makers of the engine connected it as shown. The engineer also wanted an automatic relief valve put in the pipe line, but the valve *B* was used instead.

The lights were on but a few hours, morning and night, and this small engine had to be cut in to the receiver connection while the mill was running. It was the custom to open the valve *B* in the morning and leave it open until the lighting engine was started in the afternoon. Then, while one man closed the valve *B*, another would open the valve *A*, which was placed where the back-pressure gage could be watched. It was, therefore, an easy matter to open the valve and keep a nearly even pressure.

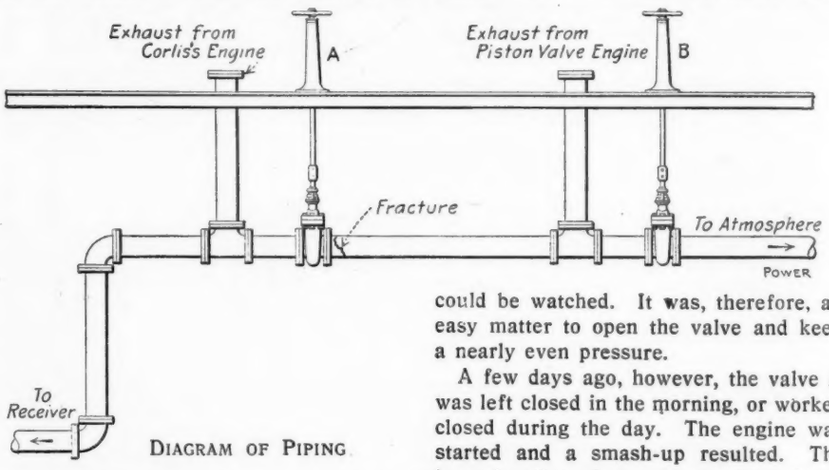


DIAGRAM OF PIPING

A few days ago, however, the valve *B* was left closed in the morning, or worked closed during the day. The engine was started and a smash-up resulted. The irregular line shows where the exhaust pipe burst.

It is my opinion that the valve *A* was open just enough to allow the pipe to partly fill with water, thus causing the trouble. The engine had hardly turned over when the crash came. It is not strange that the exhaust pipe burst, but just why the engine was smashed so badly is puzzling. The engine accident indicates water in the cylinder while running at full speed, but the exhaust-pipe fracture would suggest water hammer.

Exeter, N. H. L. JOHNSON.

How to Condense Steam

I am working in a small steam plant where the drinking water is not fit to use.

Can some POWER reader give me an idea of how to get up a cheap, convenient device to condense sufficient steam to get a couple of gallons of good drinking water a day?

E. G. ELDRED.

Ellensburg, Wash.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Smoke Abatement

I agree with Henry D. Jackson, in the April 11 issue, on preventing smoke by the coking method of firing. I have used the coking method with good results, and prefer it to the spreading or alternate method for most kinds of coal. With this method we have had hardly any smoke, except when crowding the boilers beyond their rating, and then we did not have as much smoke as when other methods of firing were used. When burning run-of-mine coal we have had to resort to the spreading method for over the peak, which sometimes amounted to 50 per cent. overload; otherwise the coal burned too slowly.

Of course, no hard and fast rule can be laid down for firing, yet in the average plant the coking method can be used to advantage, although the fireman objects to it on account of the intense heat he must work in while pushing back the incandescent coal. If the bonus system were introduced and the fireman could see a few extra dollars in it, he would do it as cheerfully as going to a Sunday ball game.

I do not mean to say that firemen are of the shirking kind, but since they are paid a scant living wage for a 12-hour shift in a hot, dirty boiler room, with little or no chance for advancement, the inducement to save coal is not strong.

The coking method of firing and the bonus system of payment are certainly worth consideration.

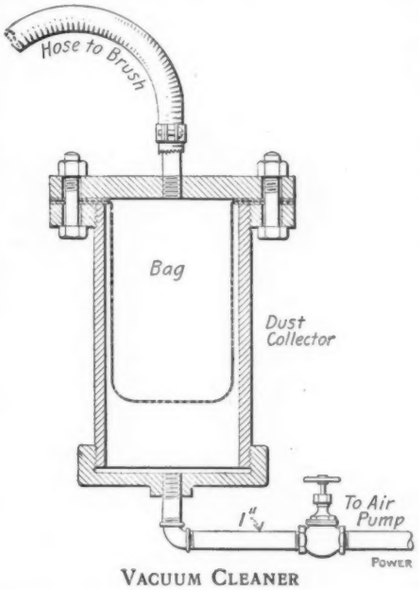
M. W. Utz.

Minster, O.

Vacuum Cleaner

S. G. Rose, in Power of May 2, page 688, asks for information upon how to construct a vacuum cleaner for use in his engine room. I will explain as well as I can how to construct a cleaner which will be found very useful in sweeping the floor and cleaning the walls and also will be found especially useful in the cleaning of street-car seats or steam-road coach seats. It can be used wherever there is an air pump or a condenser.

First, take a piece of pipe, preferably 12 inches in diameter, and cut it to the desired length (not less than 2 feet). Cover one end with a cap having a 1-inch pipe connection in it. Cover the opposite end as shown in the drawing. Make a bag out of good strong material like duck or canvas that will fit nicely inside the 12-inch pipe, not coming closer to the bottom than 6 or 8 inches. The top should be made flaring and will last longer if bound with a couple of sheet-iron rings the size of the flange. This sack is to catch the dirt and dust and is to be inserted inside the 12-inch pipe, the flaring top to be clamped between the halves of the flange union. To clean the bag, simply take it out and



Vacuum Cleaner

turn and brush it; it should go in either side out. The 12-inch vacuum chamber can be placed in any convenient location and connected to the suction side of the air pump or condenser with a 1-inch pipe, the connection being made in the bottom below the bag.

For the top there should be a 1-inch hose connection, taken preferably from the center of the flange union, or a pipe may be run from the flange union around the plant to any desired location and taps taken from it at different points, when a shorter length of suction hose will answer for the cleaner.

The cleaner may be made from hardwood, or a heavy brush may be used to advantage by cutting the bristles out of the center lengthwise of the brush, so as to form a slot about ½ to ¾ inch wide. The brush loosens the dirt and the air will draw it up into the hose. A slot will, of course, have to be cut through the wood of the brush and a holder for the hose may be made from a piece of pipe secured to the tin back with which it will be necessary to cover the brush.

J. G. Dennington.

Oil City, Penn.

Solution to Coat Economizer Tubes

In the April 11 issue, page 573, a letter was published on economizer tubes corroding, by C. B. Smith.

The conditions he described are similar to other cases where the feed water used was remarkably pure and good. The deterioration of economizer tubes first came to my notice several years ago and seemingly nothing could be done to stop it. Then I thought it might be possible to plate or coat the inside of the tubes in some way to prevent the pure water from reaching the iron. I got prices, but the cost and expense was just double the price of the economizer.

Then it occurred to me that if I deliberately formed a lime scale on the surface of the tubes that it would accomplish the result I was after. I took the matter up with the Solvay Process Company and they recommended the use of a solution of lime to form such a scale. Some barrels of lime were bought and made up into a solution; the economizer was filled up and the gases were allowed to go through it for a day or so and thereby a nice fine glazed coating on the iron was obtained. The trouble immediately stopped and the machine remained sound and good for the following ten years without any repairs.

It is well known that lime is more soluble in cold water than in hot. Hence, I made a cold-water solution and, passing the gases through the economizer, the water precipitated the lime compound on the iron surface.

I would recommend that the next time after Mr. Smith's economizer has been bored and cleaned out, he have such surface coating applied to his machine and see if it does not stop further corrosion. This coating is as thin as tissue paper and makes no noticeable falling off in efficiency.

I do not think the coating has ever been renewed and, on account of the

pure water, no scale continues to form appreciably. Before, the scale was formed principally from the iron itself. I have applied the same treatment to one or two other machines where similar trouble showed, with success and no further complaints of corrosion.

H. G. BRINCKERHOFF.

Boston, Mass.

Cooling Hot Bearings

On the inquiry page of the April 18 issue of POWER, H. C. B. asks for the best way to cool hot bearings while running and the answer is, "Use graphite and oil." I am aware that this mixture is what may be termed the standard cure for cooling hot bearings but, according to my experience, a good deal depends on other things. The best way to feed this mixture has always seemed to me to be through the oil or grease-cup hole, using a plug of wood to stir it through and having the mixture slightly warmed so that it runs through easily. Then, if the oil grooves in the bearing are cut on the small side or are shallow, this method of cooling off will not be so efficient as it will be if they are deep and of generous proportions. The same remark applies to short grooves leading "nowhere" which are not to be compared to crosscut grooves.

Another factor in the successful application of the graphite-oil mixture is the material of which the bearings are composed. Babbitt or antifriction metals are not as quickly cooled by the graphite-oil mixture as are gun-metal or bronze bearings. For antifriction metal bearings I prefer to use flake mica mixed with a good lubricating oil in the proportions (by weight) of 16 parts of oil to 1 part of mica. This mixture has indeed always seemed to me to be at least as efficient, if not more so, as the graphite-oil mixture in curing hot bearings, although I do not advocate its continuous use. I have been successful with the mica-oil mixture in cases which the graphite-oil treatment would not look at, and am acquainted with a railroad engineer in the running department of one of the largest railways in this country who advocates its use for locomotive hot boxes, although he uses more mica in his composition than I do for ordinary bearings—I think his is a 10 to 1 mixture.

Only a few weeks ago a friend of mine was having trouble with the gear box of his 25-horsepower automobile. This would run very hot in spite of all he could do and even the thickest oil he used would become thin enough to run out through the ball bearings and make a nasty mess in the undershield. The gear box has been back to the makers twice but has been returned, each time running hot again. The ball bearings are not the cause of the trouble, which appeared to originate with the gear wheels of the fourth speed, which is indirect and which my friend uses most of the time to save his engine. After he had tried oils and greases of all kinds and consistencies, including all sorts of graphite mixtures, I proposed giving the mica-oil mixture a trial. He did so with perfect success attending the experiment. The mixture was 15 parts of Vacuum Mobiloil, "C" grade, to 1 part of flake mica. I am inclined to the opinion that flake mica—more so than flake graphite—forms a more substantial cushion between the bearing surfaces, be they journal and brass or tooth against tooth, and it is not so easily squeezed out.

I have a case on hand at present of a 6-ton motor lurry, in which the steel timing wheels at the front of the engine make a loud buzzing noise in spite of their oil-tight casing being filled with lubricant of good repute and the right consistency. Encouraged by the success attained by it in the gear box above mentioned, I am going to give the flake-mica mixture a trial in this case. Were the gear-wheel case open to the engine-crank case I should hesitate before trying a mixture of more than 1 part of mica to 20 parts of oil because, the engine being provided with forced-feed lubrication with drilled crank shaft, connecting rods, etc., I am afraid that the small passages in these parts might become choked with the flake, with perhaps serious results to the engine.

JOHN S. LEESE.

Manchester, Eng.

The Position Higher Up

Mr. Miles' article on the above subject in the May 2 number contains some good points and moves me to submit a few comments on the subject of advertising for positions and answering employers' advertisements.

In writing an advertisement for a position it seems to me it should contain a brief description of ability, an offer to refer to past employers, a mention of sobriety, and, last but not least, a willingness to accept the position on trial.

I have always found it an easier matter to write an intelligent advertisement than to answer one of the ordinary kind placed by many employers. Even after corresponding with them it is a difficult matter to get them to state the full particulars of the position in question.

Several years ago I placed an advertisement for a position that would pay not less than a stated amount, and received an offer as head engineer in a 600-barrel flour mill in a small town of a few hundred inhabitants.

On asking for full particulars they informed me the mill operated day and night, I would be expected to do my own firing, and the plant consisted of two boilers and one Corliss engine.

I accepted the position and on arriving found two boilers, one Corliss engine, one high-speed engine driving a generator furnishing lights for the village and the mill, and one engine running the elevator. In addition there was a geared locomotive used for switching purposes to be kept in repair.

I refused to remain under those conditions, and was therefore out the expense of a 500-mile trip that could have been avoided had they given me the full particulars.

We often see an advertisement reading something like this: "Wanted: First-class engineer to take charge of complete steam-power plant. State experience and salary desired. References required."

There is nothing intelligent about such an advertisement. Possibly it is a 6000-horsepower plant and again it may be only a 1000-horsepower plant. If one were to make a price to fit the former and the plant was of the latter, possibly he might lose just the position that would suit him best. It might have been an uptodate plant in the locality he desired and had he known it could have made the price accordingly. The chances are the letter would never be answered.

JOSEPH STEWART.

Hamilton, O.

An Engineer's Views

Referring to the editorial on the first page of POWER of February 21, it is only too true that a great many of us do become so absorbed in the routine work that we fail to see the advantage of adopting some new method or appliance, and at other times we realize the advantage but wait for some favorable opportunity to explain our views, and while we are waiting some specialist comes in and recommends that such and such be done. It also often happens that when the engineer does advise the purchase of some new machine or appliance, he is not prepared to show just what the advantages are or what the saving will be, while the expert is loaded with the necessary data to prove all that he claims. It would be unreasonable to expect the operating engineer to be as well posted on all subjects connected with the power plant, as half a dozen specialists would be on the different subjects.

The engineer and manager should be on friendly terms and should understand each other and the conditions under which the plant must be operated. The engineer should endeavor to prove that, while he is a necessity, he is the most valuable man on the place, not by doing all the dirty jobs that no one else wants to do, but by keeping up with the times, being posted on the latest and most improved methods, and last but not least by putting his knowledge into effect. A few years ago the engineer was the one called on to do all the odd jobs that no one else was willing to do, while today

there are hundreds of plants where the engineer is highly respected and has all the authority he wants. There are hundreds of managers and owners looking for men capable of assuming the responsibility of their plants and making a success of them.

The refrigerating engineers have recently organized the Practical Refrigerating Engineers' Association, for the purpose of educating and elevating its members, and their constitution plainly states that the association shall at no time take part in any strike or anything that will in any way interfere with perfect harmony between its members and their employers. Owners and managers are eligible to associate membership and are welcome at any and all of their meetings. It is the earnest desire of the association to create a more friendly feeling between its members and their employers than generally exists.

J. B. EMBREY.

Shreveport, La.

Water Coils Burn Out

On page 534 of POWER, April 4 issue, is an article by R. A. Booth about water coils burning out. I would suggest that all the return bends be taken off and manifolds substituted. It is evident, with the coils burning out so rapidly, that the pipe is not always filled with water.

Suppose the boiler is being fed lightly, then the water having a slow but forced circulation would gradually increase in temperature until steam was generated. This would, of course, allow the coils to be burned.

To obtain proof of this, Mr. Booth could attach a thermometer cup to the line after it leaves the coil to enter the boiler.

If the feed pipe, after leaving the coil, does not come out of the brickwork, it would probably be an easy matter to extend the pipe and return it so that the temperature of the water could be taken. By doing this Mr. Booth might also obtain an answer to his second question, "Do these coils increase the efficiency or capacity of the boiler?"

Mr. Booth also asks what advantage the coils have over other kinds of feedwater heater? This is a question that can be best worked out individually. If Mr. Booth has plenty of exhaust steam that is going to waste, then without a doubt a good first-class exhaust-steam heater would raise the temperature of the feed water to around 212 degrees and would be a good investment. If the temperature of the feed water cannot be raised economically beyond 120 degrees, then I should think the coils would have the advantage.

Some time ago, at a plant where I worked, they decided to try coils in the furnace. The boilers were forced pretty hard and were fired with anthracite coal. Everything went along smoothly for about a month; then came the climax in the shape of a return bend bursting. Both fire doors were blown open and hot water, ashes and coal enveloped one of the coal wheelers, badly burning and scalding him. The brickwork inside the furnace had to be renewed.

G. H. HANDLEY.

Newburgh, N. Y.

The Line Shaft Breaks

The question in reference to the breaking of line shafts in POWER for May 2 comes under my observation and practice, generally with the following results: Hemp rope is continually expanding or contracting with weather conditions, and on the single-rope, or what is better known as the independent-rope, drive always gives the most trouble from breakage of the shafting. Take Fig. 1 for an example, which shows a central wheel with bearings placed a considerable distance from the hub. The shaft is sure to break sooner or later. By moving these bearings close up to the hub, the danger of breakage is greatly lessened.

The tension of the rope causes a continual springing of the shaft, and, to further sustain this statement, the shaft invariably breaks in damp weather when the rope would be the tightest. Another reason is that the rims of large rope wheels vibrate, due to the side swing of the rope. I believe this also tends to spring the shaft and compels it to yield when the bearings are placed as far apart as shown in Fig. 1. By moving the bearings *A* and *B* closer to the hub a much better support is obtained.

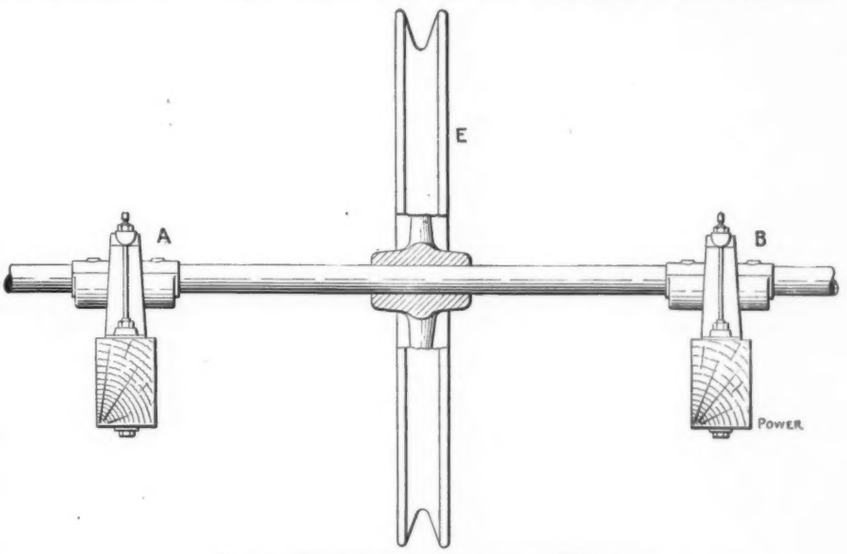


FIG. 1. BEARINGS TOO FAR FROM WHEEL

Fig. 2 shows another example in shaft breakage. I have seen this both in belted and rope-drive wheels. The same shaft was broken several times in the same place, the break occurring in each case at the center of the hub, which was made with a long counterbore. This break would always occur at *M*. On one occasion the hub was bored out up to the counterbore and a sleeve inserted. No further trouble was experienced. Whether this proves the case or not it is a practical example. Possibly a piece of shafting was secured that was more homogeneous.

I believe that Mr. Rathman will find that his trouble comes from lateral vibration and such lack of bearing support as will prevent springing of the shaft. The mere fact that a bearing is placed near the sheave wheel does not always assure the wheel of proper support, as many bearings are so loose and frail that they do not serve their purpose.

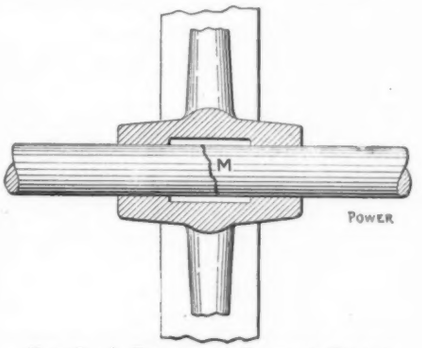


FIG. 2. A FREQUENT CASE OF SHAFT BREAKAGE

C. R. MCGAHEY.

Baltimore, Md.

In the May 2 number, A. Rathman asks for the probable cause of the breaking of his shafting, also a remedy therefor. He has hardly given sufficient data for accurately diagnosing his case, for he might have mentioned the number of revolutions the shafts are making per minute, the distances between the hangers and the pulleys, the kind of machinery driven, etc. In the absence of such details only general suggestions can be offered.

Seeing that the shafts are carrying rope sheaves they should be proportioned for head shafts. Applying a rule used by Jones & Laughlin for cold-rolled iron shafts of this class, hangers not more than 8 feet apart, the following formula is obtained

$$H.P. = \frac{Dia.^3 \times r.p.m.}{100}$$

It will be found that the $2\frac{5}{16}$-inch shaft, to transmit 50 horsepower, must run at a speed of not less than

$$\frac{50 H.P. \times 100}{2\frac{15}{16}^3} = 198 \text{ revolutions per minute}$$

In the same way the $2\frac{7}{16}$-inch shaft, to transmit 20 horsepower, must run 138 revolutions per minute. If the shafts run slower they are overtaxed. When shafts are so loaded and supported that the deflection amounts to more than 0.01 inch per foot of clear length between bearings, they are apt to break. To guard against this use hangers at shorter intervals and, if possible, place a hanger close to each side of a sheave. If the full power is delivered by one sheave located in the middle of an 8-foot span, the $2\frac{15}{16}$-inch shaft ought to be increased to $3\frac{3}{16}$ inches.

It is stated that the shafting is in line; but while this may have been the case once, it should be verified periodically, especially after an accident, and the anchor bolts of the hangers tightened. Care should also be taken to allow sufficient end play, the shaft collars and couplings being set to allow full sway to expansion resulting from heating. A shaft 245 feet long will, in warming up from 60 to 110 degrees Fahrenheit, increase one inch in length.

If the shafting suffers from irregular vibrations, it might be advantageous to place a few small flywheels on it for equalizing. Keyways are known to weaken shafting and to affect its alinement. The diameter should therefore be increased, or split pulleys and couplings used, which are merely clamped to the shafting and strengthen instead of weaken it.

If the path of the ropes is not steeper than about 45 degrees from the floor up, the drive may, as a last resort, in some places at least, be changed over from the American system with its one continuous rope, to the English system with a number of independent ropes. In this way the shafts may be slightly relieved and in case one rope breaks the others will carry the load until opportunity permits making repairs.

CHARLES H. HERTER.

New York City.

Judging from the sizes of shafting given by Mr. Rathman and supposing that they run at a moderate speed, the shafts should easily deliver the power mentioned without being strained, but the fact of their breaking is evidence of a strain beyond their power to withstand.

From the article it would appear that the shafting is suspended from the ceiling by hangers. I have seen hangers sprung out of line considerably by belt tension, thereby causing the very trouble of which Mr. Rathman complains. This can easily be tested by taking a broomstick, driving a wire nail into each end, the whole being long enough to reach from some point near and to just touch the shaft when stationary. Put the shaft in motion and the stick will show any bending or nonalinement.

I would next look at the distance from center to center of the bearings on each side of the driving wheels and would endeavor to place them as close as conditions will permit. If the bearings are as close as possible, then a new shaft should be installed with a "swell" of at least ½ inch where the driving wheels go and let the larger diameter extend some distance on each side.

I have in mind one shaft which had given a lot of trouble and had been replaced several times. Increasing the size did not overcome the trouble. When the broomstick method was tried it was at once apparent that the supports on the ceiling were not rigid enough to stand the strain when the shaft was in operation. The shaft was then placed on proper foundations on the floor, and no further trouble was experienced.

C. F. SAMPSON.

Philadelphia, Penn.

If Mr. Rathman's shaft is in line and is not overloaded. I would suggest that a hanger be placed near the sheave. Without much doubt the distance between the hangers is too great, and when the shaft is carrying the load the strain is at the sheave.

ALBERT T. GUILMAN.

Stafford Springs, Conn.

Installing Oil Burner

On page 694 of POWER, May 2, E. W. E. asked for a little information on installing oil burners.

Having had some seven years' experience in that line of work, I would say that the answer gives him the *little* information, and very little at that, especially if he is in no way familiar with oil burning.

The proper arrangement of a furnace for the economical burning of crude oil depends on several conditions, one of which is the kind of boiler under consideration. As he does not state this, I will suppose he means a standard return-tubular boiler of the class usually employed in stationary work and 66 inches in diameter by 16 feet in length. In this case the bridgewall should be entirely removed and the grates should not be less than 24 inches or more than 36 inches from the shell of the boiler for economical results. The combustion chamber should be filled up with earth to within 16 inches of the shell at the back end of the boiler and continued on an incline toward and meeting with the back end of the grates, and may be rounded slightly up toward the side walls.

The entire surface should be covered with firebrick, including the grates, excepting a space 12x18 inches in each corner at the front of the furnace. These will admit a sufficient amount of air for most cases. Aside from this the interior of the furnace need not be changed from what it was for burning wood or coal.

The blowoff pipe should be protected by a firebrick pier built up in front of it to where it enters the shell. The burner should be set in the center of and extending into the furnace 4 inches beyond the door-jamb line. The distance from the top of the firebricks on the grates to the center of the opening in the burner should be 6 inches. Be sure to set the burner exactly level. If it is allowed to slant downward, the flame will strike the bricks and reflect against and injure the boiler shell. If it points upward, the oil will not burn steadily and the boiler, as in the other case, will be injured.

The opening in the burner tip should be of a sufficient width to just allow the flame to reach the side walls when working at its full capacity. If this plan is followed, no damage will result to the boiler under the heaviest firing. However, care should be taken not to crowd the fire until the setting has become thoroughly heated up.

CHARLES F. KING.

Portland, Ore.

Buying Coal on B.t.u. Basis

I have followed with a great deal of interest the numerous articles in POWER from the scientific writers who have been urging that a little more science is all that is required to make everything lovely in the power house, but I am afraid that these writers too often overlook the problems of human nature and established commercial conditions.

For instance, I have been greatly impressed with the arguments in favor of the purchase of coal on a B.t.u. basis, so I decided hereafter to buy heat units instead of mere carbon and ashes, and solicited bids from numerous mines for a shipment of 400 tons of pea coal for gas producers, payment to be made on a basis of B.t.u. Practically every mine on the line of the Central Railroad of New Jersey (to which we are bound hand and foot) replied in effect that they did not take any stock in heat units and I could buy the coal just as they offered it or go without, as I chose.

I agree in the abstract with everything that the scientific men have written, but, unfortunately, very few of their suggestions can be carried out under present conditions.

S. W. RUSHMORE.

Plainfield, N. J.

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POWER

The Oil Engine

There is probably no field in which prophecy is more futile or less likely to be vindicated than in engineering. People are continually developing apparatus which had been solemnly declared impractical years ago by those versed in the scientific principles involved. For example, before steamships were fully developed it was asserted by authoritative students of the subject that Fulton's efforts, while laudable and practical within a very restricted range, could never result in transatlantic steamboats because a boat could not carry enough coal to keep up steam throughout such a long trip, even if the engine could be made to run continuously, which was considered highly dubious. It was also proclaimed that Professor Langley's optimism regarding the possibility of building a flying machine was without solid scientific foundation because it would be impossible to make an engine light enough to enable it to sustain its own weight and that of the machine and the operator.

The same general kind of predictions have been made concerning the future of high-compression oil engines such as the Diesel. In the first place, the supply of petroleum products could never be sufficient to meet the requirements of any very large aggregate of power output; in the second place, the nature of the operating cycle demanded the unremitting care of a corps of highly skilled technical nurses which would cost more in excess wages than the saving in fuel expense and fixed charges would cover. These predictions are apparently being refuted as effectively as the others have been. Recognizing the limited supply of crude petroleum, the Germans have resorted to the production of fuel oils from almost as many and as unsuspected sources as have been pressed into use by makers of American breakfast foods. Also realizing that men trained in high-grade manufactories are not commonly obtainable in Siberian wastes or South American jungles, they seem to have raised the mechanical structure of the oil engine to such a degree of dependability as to encourage its use almost outside the geographical limits of civilization.

We are reliably informed that the Diesel type of oil engine is in actual use in Siberia, under mechanically low-grade supervision, to the extent of thousands of horsepower, and we sincerely take off our hat to the men who have achieved the results which make such a thing possible and express a cordial wish that American engineers may emulate their fine example.

Mathematics and the Engineer

It is, perhaps, unfortunate that comparatively few operating engineers are mathematicians and that any matter containing algebraic signs is avoided like a pestilence by the most of them. But there is this mitigating condition: Mathematical talent and practical fitness for the care and operation of moving machinery are seldom found in one individual.

It is, however, fortunate that all of the mathematical knowledge that is really needed by an engineer may be readily acquired by anyone who has the attainments expected in a schoolboy fourteen years of age. It is not so much the lack of the little skill necessary to handle algebraic formulas and elementary trigonometry that handicaps the operator as his aversion to logical thinking.

As a boy, when playing seesaw, he instinctively took such a position on the plank that his weight balanced that of the boy on the other end, but he did not then, and probably has not since, considered that his weight multiplied by his distance from the supporting trestle or the fence rail exactly equaled the product of the other boy's weight and his distance from the fulcrum. If he had, and in consequence of this consideration had calculated the weight of his playmate from the relative distance of his seat from the fulcrum, no safety-valve problem would require the hours of study sometimes given to the subject.

There is no good reason why the engineer should balk at algebra or trigonometry. The formulas are merely a "shorthand" way of writing a rule and they are much simpler and more easily remembered than the long-drawn-out statement of the same operations expressed in cumbersome English. When the electric generator, the refrigerating system, the air compressor and the hydraulic elevator were placed in his charge, the engineer did not balk because he did not understand them. He

tackled the problems man-fashion and mastered them.

If he would pursue the same course with mathematics he would be surprised at the shortness of time in which formulas that previously seemed hopelessly complicated became clear.

No investment that an engineer can make will pay such dividends as time spent in the study of the elementary branches of the science most nearly related to his work.

Practice and Theory

At the recent meeting of the American Society of Refrigeration, in Chicago, it was said that when a need arises in this country for some application of refrigeration, when something needs to be done and done quickly, we go ahead and do it and then send to Germany to find out how we did it.

The one illustrates practice, the other theory. Seemingly they do not always go together. For instance, theory says that we should always keep the fire doors closed; that air, admitted over the fire, results in cooling the gases of combustion and therefore decreases efficiency. But many firemen who never heard of a heat unit have discovered that leaving the door cracked open immediately after firing results beneficially.

Careful experiments with pyrometers in boiler settings have verified the fact that the temperatures are actually higher and more water is evaporated when the door is opened slightly immediately after firing, than when the door is kept closed.

The nontheoretical fireman who first found this out was satisfied to know what he knew without knowing why he knew it, but the man who made the pyrometer experiments was not so easily satisfied. He called on theory to explain and theory responded with an explanation.

Of course, after practice had pointed the way it was easy to show that on account of the large amount of volatile matter being distilled from a freshly replenished fire, better combustion could be obtained by allowing some air to enter directly over the fire and burn the gases, which otherwise would not get sufficient air through the grate and would pass off unburned. Theory did not lead the way in this, however; it was practice which first demonstrated it.

The moral is: Do not be hedged in too closely by the theories that you already know; by trying something that seems to be contrary to those theories you may do something better than it has ever been done before, and the theoretical law governing the case will be promptly brought to the front. But do not take this as advice to waste time and money on things that clearly violate fundamental natural laws, such as perpetual-motion schemes.

The Passing of the Piston

Eight years ago we published an editorial under the above title. With the passing of the years the tendencies which were the theme of that article have become more marked. For large electrical work nobody thinks of anything but the steam turbine which is now built in units of twenty thousand kilowatts, with no indication that the limits of capacity or of efficiency have been reached, and is developing a horsepower-hour on less than ten pounds of steam.

More than four million kilowatts capacity have been sold by the three large companies, the far greater proportion of it since the editorial in question was written. The small steam turbine is making serious inroads into the field of the high-speed automatic engine. The turbine pump is continually winning favor even for pressures as high as those required for boiler-feed service.

And now comes the centrifugal blowing engine to contest the field with the massive air tub driven by a slowly running reciprocating engine. A sixty-thousand-foot centrifugal blower turbine driven with condenser complete can be had for sixty thousand dollars. A gas-engine driven blowing engine of the same capacity would cost two hundred thousand. Is the greater efficiency of the gas engine worth this difference in cost?

Chimneys

A subject about which the average engineer knows very little is that of chimneys. He may have a somewhat hazy recollection of having been taught that the principal factor affecting natural draft is the difference between the weights of the column of gas within the chimney and that of the outside air; but if called upon to calculate the size of a chimney he would probably be all at sea.

Both Rankine and Peclet attempted to solve the problem from a theoretical standpoint, but their formulas were more or less involved and it was found hard to apply them to practice. Later authorities have formulated empirical rules, but their constants have differed widely and the results, as a whole, are far from satisfactory.

The design of a chimney is much more complex than determining the dimensions of a steam engine to produce a given power at a given steam pressure and piston speed. In the case of the steam engine most of the quantities are fixed or under complete control, whereas, with the chimney, so many variables enter into the problem as to make it indeterminate except for assumed conditions. If more coal is to be burned per square foot of grate surface it means a larger volume of gas passing up the chimney, which must be provided for by increasing either the area or the velocity, the former requiring a larger diameter of chimney and the latter a greater hight. Furthermore, different thicknesses of fuel bed require different intensities of draft, or a wind blowing over the top of the chimney may produce suction and increase the draft. The length of flue, number of bends and the path of the gases through the boiler, all have their effect upon the draft.

With such conditions, it may seem strange that so many chimneys are built which successfully meet the conditions of service. The fact is, however, that chimney designers, while employing empirical formulas to a certain extent, really depend more upon their experience and the large amount of data at their disposal than upon the formulas.

A Good Suggestion

At the Illinois State convention of the National Association of Stationary Engineers, a valuable suggestion was made regarding the possibility of the organization coöperating with the University of Illinois in educational work. The Illinois State Association has an educational committee the duty of which is to promote, in one way or another, interest in engineering subjects among the different local associations.

This has been done by issuing, periodically, a list of questions to be answered by the associations, with a prize for the highest grade during the year, and by giving lectures on various engineering topics at different points in the State.

The suggestion was to consider the possibility of arranging with the university an annual meeting extending over perhaps two days and one night, at which lectures would be given and tests run on various power-plant equipment available in the laboratories, the subjects being such as would appeal especially to men engaged in the steam-engineering field.

There is no doubt that the university would welcome any such arrangement. A great deal of the information now gathered by the university is ineffective merely because of the failure to get it into the hands of the proper persons. One of the former professors, happening to be in the engine room of a power plant and noticing some bulletins of the university on the desk, asked the engineer how he came to get them. The reply tells how a great deal of this material goes to waste: "The university sends the bulletins to the superintendent; he throws them into the waste basket and I pick them out!" Undoubtedly there is too much of this waste-basket circulation.

It is to be hoped that there will in the future be more of an organized effort on the part of engineering societies toward closer relations with the various institutions of learning, not only in Illinois, but elsewhere.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Steam Engine Regulation

I have a 16x42-inch Corliss engine which takes steam full stroke a large part of the time. If I change the length of the knockoff rods to give a longer cutoff, the engine lags and seems to have little power. What can be done to improve the regulation?

W. H. M.

It appears that your engine is either overloaded or the valves are not properly adjusted and should be reset.

Place the wristplate in the middle of its travel; adjust the valve connections so that the steam valves will have 5/16-inch lap, and the exhaust valves stand open 1/32 inch. Block the governor 3/16 inch above the rest, and with the engine turning over slowly adjust the knockoff rod so that the head-end valve will unhook and the crank-end valve hook will just touch the knockoff block.

Changing the length of the rod as you do will only throw the governor out of adjustment, without helping in any way, and may be the cause of a runaway engine with a light load.

Pitch of Grates

Why are the grates in a boiler furnace pitched toward the back of the furnace?

C. H. M.

Grates are inclined toward the bridge-wall for the purpose of making it easy to distribute the fuel and to rake and slice the fire. It also tends to make the fuel bed thicker at the back of the furnace where the air tends to pass most freely.

Vibration of Reach Rod

We have a Corliss engine the rod to the steam valves of which vibrates to such an extent that it is feared it may break The rod to the exhaust valves does not vibrate. The rod in question at the carrier arm is reduced from 1½ inches to ⅞ inch. Will you give an explanation and remedy for the vibration?

A. E. S.

Vibration in the reach rods of Corliss engines is frequently caused by insufficient lubrication of the steam valve. It is usually most severe during the first hour's run. The dimensions of the rod are carefully calculated by the designer and are, as a rule, safe for the work they have to do. The vibration may be stopped by hanging a small weight to the middle of the length of the rod by a cord which will allow it to swing clear of the floor, or by a light truss on the underside of the rod. There is, so far as is known, no record of the breaking of one of these rods from excessive vibration.

If the vibration is severe and attention to valve lubrication does not remedy it, the matter should be taken up with the engine builders.

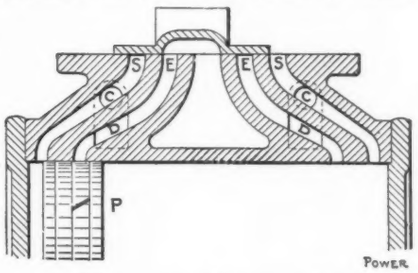
Duplex Pump Valves

Does increasing lost motion of a valve on a duplex steam pump lengthen the stroke? What keeps the piston from striking the head?

O. W. P.

Increasing the lost motion of a valve in a duplex steam pump lengthens the stroke.

In the duplex pump as the piston approaches the end of the stroke it covers



SECTION THROUGH VALVE OF DUPLEX PUMP

the exhaust port, trapping some steam, which by compression stops the piston before it reaches the cylinder head, as may be seen by the sketch, in which *S S* are the steam and *E E* the exhaust ports. *D* is a cross passage from the steam to the exhaust port controlled by a valve at *C* which determines the amount of compression by regulating the flow of steam through the passage to the exhaust port after it has been closed by the piston.

Temperature Rise of Dynamos and Motors

What rise of temperature is safe for a dynamo or motor?

C. F. J.

Field-magnet coils and armature, 80 degrees; commutator and brushes, 90 degrees; bearings and other parts, 75 degrees, all Fahrenheit.

Effect of Service on Lamp Filaments.

When an incandescent lamp has been in service a long time, does it pass more current or less than it did when new, and why?

C. E. B.

It passes less current, because the filament wastes away during service, reducing its cross-section and thereby increasing its resistance. The candlepower decreases more rapidly than the filament section, however, so that the current *per candlepower* is greater than when new. A 16-candlepower lamp taking ½ ampere new will take about 0.47 of an ampere after burning 500 hours, but its candlepower will be reduced to about 13; the current per candle, therefore, is 0.03125 of an ampere when new and 0.03615 of an ampere after burning 500 hours.

Combined Motive Powers

Is it feasible to help out an overloaded steam engine by belting an electric motor to the line shaft to which the engine is belted?

B. S. Co.

Entirely so. It is only necessary to make the pulley ratio such that when the motor is running free, with normal field excitation, its speed will correspond to the normal speed of the line shaft. A small adjustable resistance in the field circuit of the motor will enable you to regulate the amount of power it delivers to the line shaft; cutting in resistance will increase the power delivered, by causing the motor to try to run faster, and thereby relieve the engine.

Why Allow Any Drop?

Why is any drop in voltage allowed in electrical circuits?

T. Y. H.

For the same reason that a bearing is "allowed" to consume power and heat is "allowed" to get away up the chimney of a steam boiler. Because it cannot be prevented. The drop in voltage is due to the electrical resistance of the conductors through which the current passes and there is no material yet discovered which has no resistance.

Large Wire Gages

In speaking, how are the large wire sizes, such as Nos. 00, 000 and so on, expressed?

T. Y. H.

Number two nought, three nought, etc.

Baffles for Curtis Turbines

On the vertical Curtis turbine, a baffle similar to that shown in Fig. 1 is used between the oil pump and the step bearing. The oil, entering at the left, passes through a sieve of wire gauze and then through the threads of the helix *A* to the outlet. By screwing the bolt *B* further into the helix the latter is driven to the right and the tortuous path of the oil shortened. It serves, in effect, as a throttle valve for the oil, and prevents its sudden escape backward and the consequent sudden dropping of the step in case of the failure of the oil pressure.

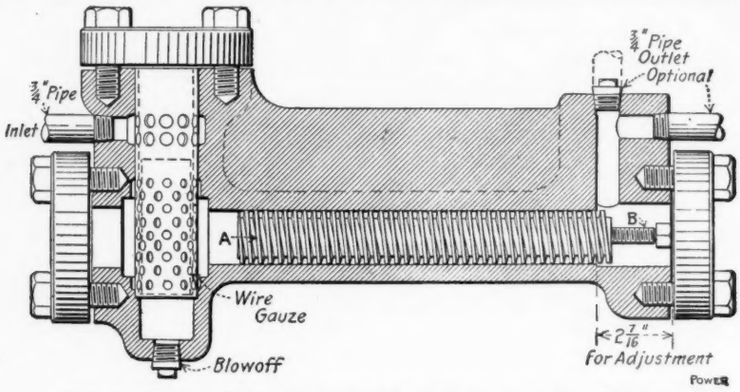


FIG. 1. BAFFLE USED BETWEEN OIL PUMP AND STEP BEARING

These baffles are ordinarily made of cast iron, and at a station where they are used under a pressure of 1500 pounds per square inch they failed after a year or two of service. An attempt was made to cast them in bronze to a pattern made to conform to Fig. 2, but out of a lot of 20 only one was found to withstand the required test pressure of 3000 pounds per square inch.

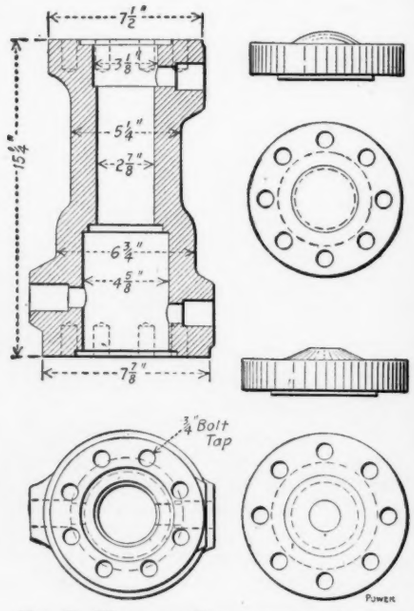


FIG. 2. WORKING DRAWINGS OF BRONZE BAFFLE

An order was then placed with A. Allan & Son for 16 to be cast in manganese bronze to the same pattern. They cast one-half of these, and out of the lot of eight only two remained tight under the test pressure. They admitted their inability to fill the order and asked to be allowed to substitute for the manganese No. 2 Allan metal, an alloy consisting of 66 per cent. copper, 25 lead and 9 tin. Permission was accorded and out of 14 made in one cast 11 successfully withstood the application of the 3000 pounds. Five of these are now in use, and it remains to be seen whether they will endure the stress of continued service better than the cast-iron prototypes.

Fig. 3 shows one of the finished castings attached to the ram for testing. The ram is capable of exerting a pressure of 10,000 pounds per square inch, and is used for taking armatures off from and putting them on to the shafts.

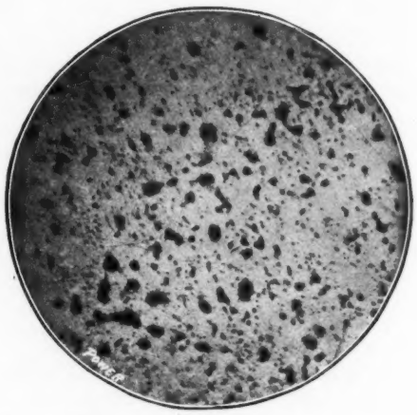


FIG. 4. ALLAN NO. 2 BRONZE MAGNIFIED 45 DIAMETERS AND REDUCED FROM 2¾ INCHES

The characteristics of the metal are given in the accompanying report of a test by Professor Pryor of samples, one from the commencement and the other from the end of the pour.

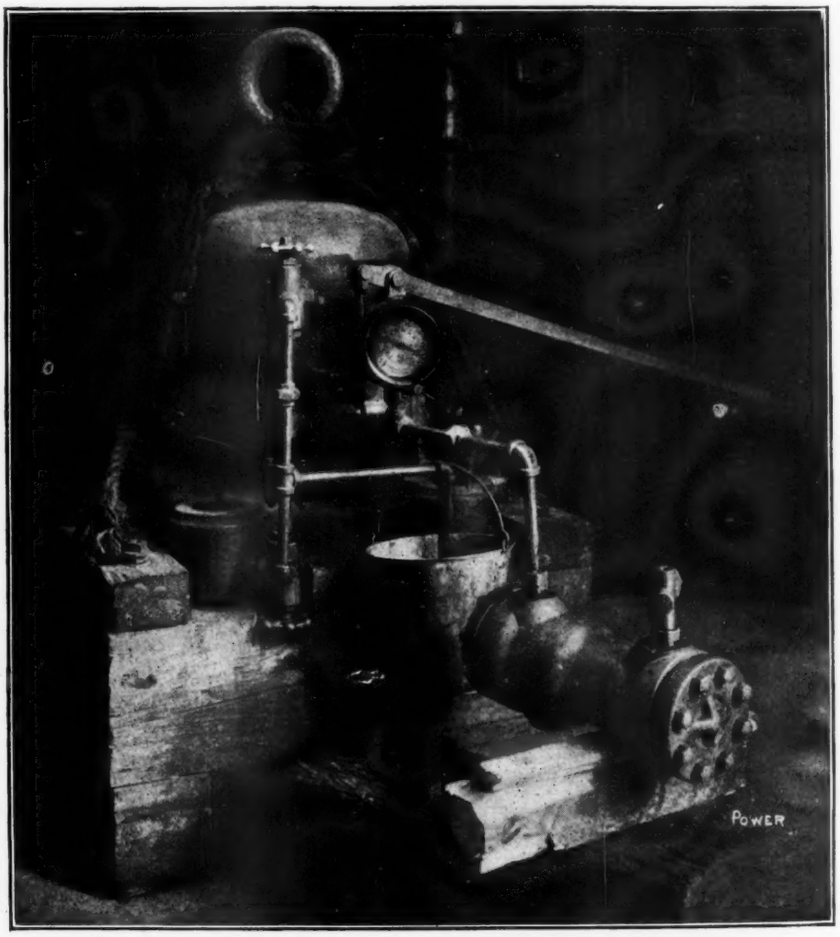


FIG. 3. BAFFLE MADE OF NO. 2 ALLAN METAL UNDER TEST

RESULTS OF TESTS CONDUCTED BY PROFESSOR PRYOR

Designation of material	No. 1	No. 2
Diameter of specimen, inches.		
Original	1.496	1.498
Final	1.460	1.470
Area of specimen, square inches.		
Original	1.7577	1.7624
Final	1.6742	1.6972
Reduction of area, per cent	4.7	3.7
Elongation, measured over 9 inches, per cent	4.4	3.8
Elongation, measured over 8 inches, per cent	4.6	3.9
Yield point, pounds.		
Actual	23,500	21,750
Per square inch	13,370	12,340
Ultimate tensile strength, lb.		
Actual	30,710	30,100
Per square inch	17,470	17,080

A microphotograph taken by Prof. William Campbell, of Columbia University,

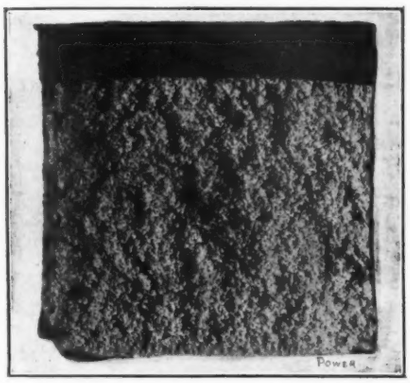


FIG. 5. A FRACTURE OF ALLAN NO. 2 BRONZE MAGNIFIED TO SHOW GRAIN OF ALLOY

and reproduced in Fig. 4, shows the density and character of the metal. The difficulty is not so much one of strength as of imperviousness or lack of porosity, and it is expected that the copper and tin will furnish the required strength and form a matrix for the lead, which will give the necessary density.

Engine Shaft Breaks

BY CAREY GRANGER

Quite recently a remarkable accident occurred at the Anderson plant of the American Steel and Wire Company. The main shaft on a 36 and 72 by 48-inch Corliss engine broke while the engine was running under full load. The shaft was 22 inches in diameter and carried a rope pulley 18 feet in diameter and 30 inches wide, also two belt pulleys 20 feet in diameter by 48 inches wide. The engine was used to drive the 12- and 18-inch trains of rolls in the rod mill and ran at 100 revolutions per minute. The two 48-inch pulleys are clamped to the shaft with the rims fitting tightly together. This leaves a space of about 6 inches between the hubs, and it was in this space that the shaft broke. On account of the rims fitting together so closely, it was impossible for the pulleys to drop into the pit and no further damage was done to the engine.

The engineer stated that, when the shaft broke, it made a noise very much like the stripping of one of the pinions by which the rolls are driven. He shut down the engine and waited for orders from the millwright who has charge of the pinions. The millwright, wondering at the stop and denying that anything was wrong in his department, gave orders to proceed. The engine was started and ran almost up to speed before it was decided that the trouble was in the engine room and an investigation started. The break was soon located, and I heartily agree with the engineer that "it is better to be born lucky than rich."

Boiler Explosion at Arcadia, La.

BY W. HOWSE

On May 8 a small portable boiler, used to drive a shingle mill near Arcadia, La., exploded, killing one man and seriously injuring another.

The boiler was of the locomotive type, 8½ feet long, with a barrel 3 feet in diameter, and mounted on it was a small slide-valve engine. Its exact age was not known, but from all accounts, it appears to have been over twenty years old. One hundred pounds steam pressure was known to have been carried, although there appears to have been no safety valve nor water column attached. The imprudence displayed in carrying so high a pressure is magnified by the fact that the boiler had lain exposed to the elements for some time prior to being installed in the shingle mill, and was in a corroded condition.

The crown sheet, which was ¼ inch thick, was ruptured in three places, each rupture extending lengthwise of the firebox. It is remarkable that very few of the threads on the staybolts were stripped, and, although some of the staybolts had been eaten away from an original diameter of ⅝ inch to that of a lead pencil, none was broken. The seams

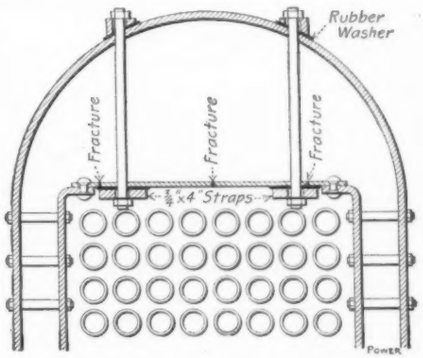


FIG. 3. SECTION THROUGH FIREBOX SHOWING POINTS OF RUPTURE

were single-riveted with ⅝-inch rivets. These conditions, together with the fact that the crown sheet showed every evidence of having been overheated, leads to the conclusion that the explosion was caused by low water.

Feed water was supplied by an inspirator which was found after the explosion with all valves set for delivering water to the boiler; although, according to the statement of the injured man, he had just started over to the inspirator with the intention of turning it on when the explosion occurred.

The boiler had been leaking around the staybolts in the crown sheet and the owner of the mill had attempted to brace it by putting ¾x4-inch straps on the crown sheet. These were held by ⅝-inch bolts extending through the top of the shell and some pieces of rubber belting were used as washers under the nuts to prevent leakage. He was tightening these nuts when the explosion occurred, which hurled him 125 feet and resulted in his death as well as demolishing the entire building.

FIG. 1. BOILER AFTER EXPLOSION

FIG. 2. REMAINS OF BUILDING

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

Improved Pressure Tubes for Recording Gages

The action of pressure on a tube or spring in a gage forces the sides apart, resulting in a greater radius of curvature,

FIG. 1. SHOWING HELICAL GAGE TUBE

following the motion of the free end. The principle of the helical form, shown in Fig. 1, is identical, for it is, in effect, a series of tubes placed end to end. When pressure is applied, it causes the tube to untwist and the free end to move a distance in proportion to the pressure applied.

In the improved helical pressure tube

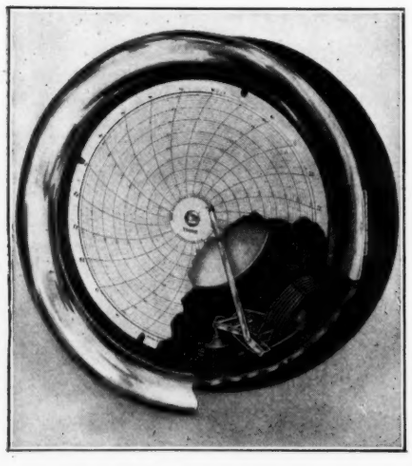


FIG. 2. BELLOWS DIAPHRAGM

for pressure above six pounds, a simple but substantial support has been devised which supplies an axis of rotation, resulting in the precise travel of the pen over a definite predetermined arc.

This support eliminates many of the possibilities of accident, as the support gives the required protection and ruggedness.

For minute pressures requiring reading in inches of water, a series of diaphragms built up into the form of a bellows are

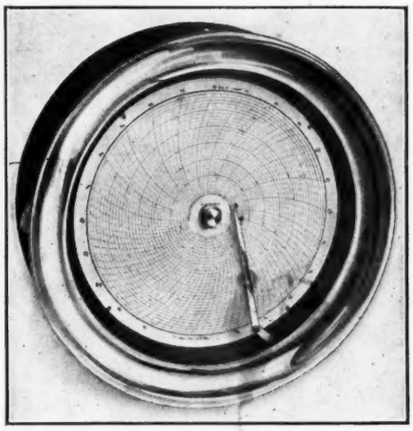


FIG. 3. EXTERIOR VIEW OF THE GAGE

employed as shown in Fig. 2. Application of pressure tends to elongate the tube, but this motion is converted into a multiplied lateral motion by means of restraining coils secured to one side of the side of the tube. The motion thus obtained is transmitted through a very simple and effective device to the pen arm in such a way as to produce a uniform scale throughout the range of the chart. The feature of support similar to that employed with helical pressure tubes is of importance when it is used in conjunction with the diaphragms. It contributes to a marked degree to positive action of the recorder, at the same time giving strength and freedom from mechanical disturbance. Although designed for extreme sensitiveness and accuracy, the improved form insures great rigidity and durability under service. The exterior view of the gage is shown in Fig. 3.

These instruments are made by the Industrial Instrument Company, Foxboro, Mass.

"Durabla" Gage Glass

There is a demand for a gage glass that will be equal to the conditions now found in steam plants, and a gage glass to fill the new conditions must withstand high pressures and severe tests.

The Durabla high-pressure gage glass of the German navy has just made its appearance in America. This glass is used by such large plants as the Krupp iron works and the Hamburg-American line. The Durabla glass is claimed to be a peculiar scientific compound all its own.

As an example of its properties, the following results of an experiment made by a large testing station in this country may be of interest:

The glasses were immersed in oil at a temperature of 350 degrees Fahrenheit, and then dropped into water at a temperature of 40 degrees Fahrenheit. The experiment was repeated fifteen times, after which the same glasses were put into use on high-pressure boilers.

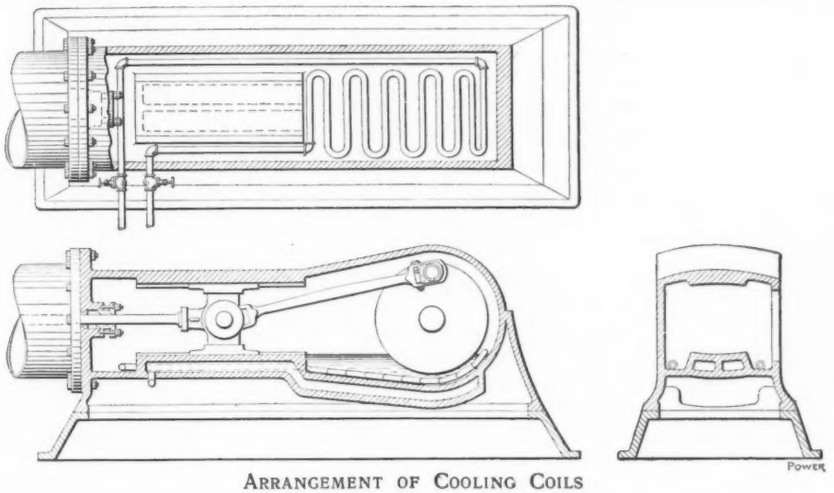
It is the mixture of different materials which gives certain glass the power to resist sudden changes in temperature, the action of steam, alkalis and impurities in water. It is the power to resist chemical action which keeps a glass clear for a long time under all conditions. The power to resist sudden changes in temperature reduces the possibility of accidents to a minimum.

DURABLA GAGE GLASS

The Durabla gage glass is manufactured by R. G. Von Kokeritz & Co., 114 Liberty street, New York City.

Oil Cooling Device for Steam Engines

This device consists of a flexible pipe entering the engine frame as illustrated, with a series of coils lying in the crank casing partly submerged in lubricating oil. A current of cool water is circulated through the pipe, after which the water may be discharged to the heater. The device is intended for application to inclosed, self-oiling engines. By regulating the amount of water flowing through the coil it is possible to keep the oil cool and eliminate, in a measure, the liability of heating journals.



ARRANGEMENT OF COOLING COILS

This device is manufactured by W. J. O'Keefe, Foster building, Milwaukee, Wis.

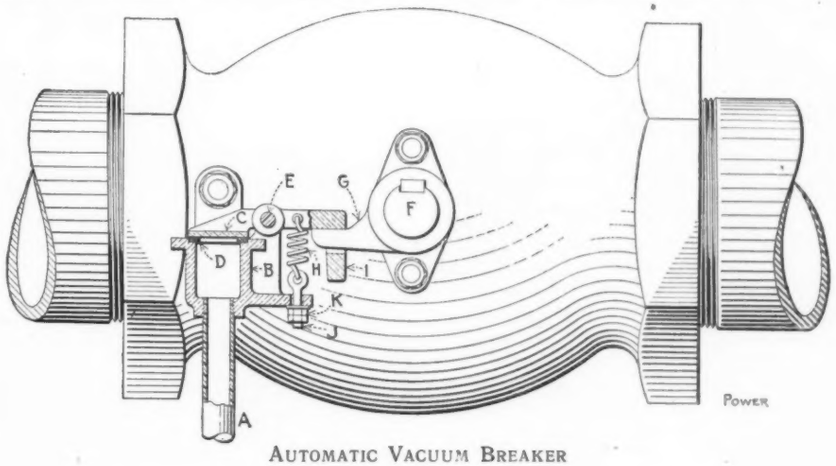
Automatic Vacuum Breaker

A new design of automatic vacuum breaker is illustrated and described herewith. *A* is a pipe connecting with the exhaust or vacuum pump and is capped with a brass head on the upper end, as shown at *B*. The top of the cap is closed to the atmosphere by the cover *C*, which fits tight on the soft-rubber ring or seat *D*. The pressure of the atmosphere or suction of the vacuum holds this cap down on the seat *D* when running normally. The cap *C* extends back and is pivoted on the pin *E*.

The spring *H* has one end fastened in the extension arm of *C* and the other end is made fast to the tension adjustment *J* which is held by the projecting ear on the cap *B* and holds this spring in tension and acting as a resistance to the suction of the vacuum on the cap *C* so as to nearly counterbalance this suction. This tension can be adjusted by raising or lowering the pin *J* by changing the position of the lock nuts *K*. In this position the vacuum suction and the spring tension are nearly balanced, the force of the suction being somewhat greater so as to hold the cap *C* fast on the rubber seat *D*.

At the end of the extension of *C* is the loop *I*. *G* is a lever-like projection made fast to the rear stem of the stop valve proper, this stem being brought through the rear head for this purpose. The stem is in the position shown when the stop valve is open. The operation of the apparatus is as follows:

Closing the stop valve causes the rear valve stem *F* to rotate in the direction of the arrowhead, carrying the lever *G* with it. This lever strikes the link *I* when the valve is in a nearly closed position and when it has the most force due to the velocity of the steam rushing through the stop valve. The force of the blow with which the lever *G* strikes the link *I* is of sufficient force to overbalance the suction of the vacuum and lifting the cap *C* from the seat *D*. The spring *H*, now having nothing to counteract its tension, pulls the extension of the cap *C* down, opening the head *A* to the atmosphere, which, being in connection with the vacuum, breaks it at the same instant the steam line is shut off, thus doing away with danger of the engine cylinder filling up with water.

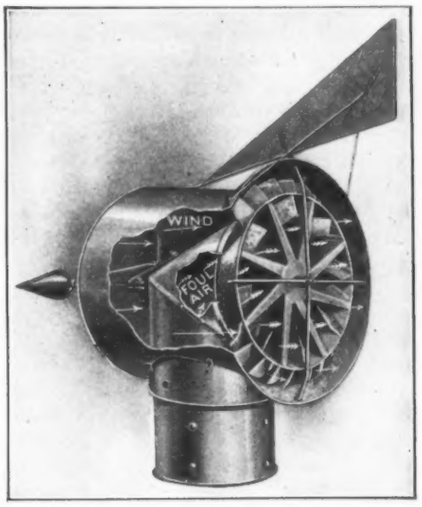


AUTOMATIC VACUUM BREAKER

When the stop valve is opened by raising the hand lever, the lever *G* is brought back into place, carrying the extension on *C* with it and closing the head *A* so that when the vacuum pump is started the suction again holds the cap *C* to its seat, cutting the vacuum off from communication with the atmosphere. The head *A* is fastened to the rear head of the stop valve proper by means of cap screws. This device is manufactured by the Automatic Engine Stop Company, Sheboygan, Wis.

Bicalky Roof Fan Ventilator

The Bicalky ventilator fan does not depend upon any difference in temperature for its action, but a rotating fan wheel creates a vacuum and causes an upward circulation of air to insure ventilation.



SEMI-SECTIONAL VIEW OF VENTILATOR

A large area is exposed to the moving currents of air which the double cone-shaped opening brings into contact with the outer periphery of the fan wheel, while the inside portion of the wheel connects with the foul-air duct.

The power and suction portions of the fan wheel are entirely separate, so that the current of air driving the wheel and the other exhausting the foul air from

the building, in no way interfere with each other.

As no motor is required to operate this fan, there is no cost for repairs, and no power bills to pay.

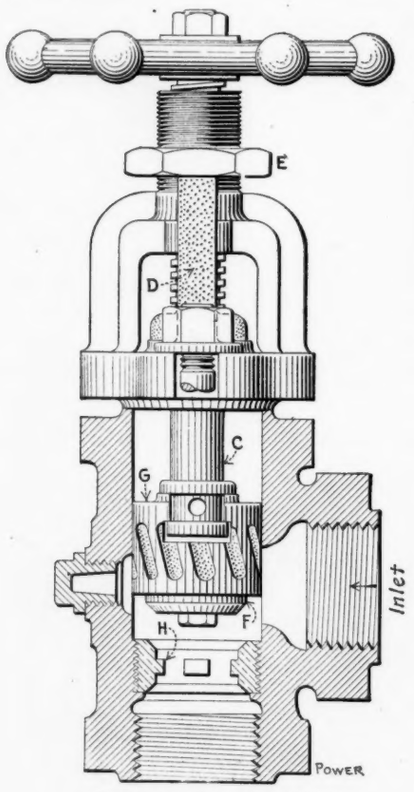
The fan wheel is mounted on ball bearings running in oil, which require lubricating once a year.

This fan is suitable for ventilating any kind of a room or building. It is manufactured by the Bicalky Fan Company, Buffalo, N. Y.

Cyclone Blowoff Valve

The body and yoke of the Cyclone blowoff valve are made of cast iron and are connected by steel studs and nuts. The sheet packing is housed in a recess in the body neck flange protecting it from a blowout, and is compressed by a projection on the yoke flange.

The stem *C* is made of a bronze composition and is cut with a square thread. The packing is secured and regulated by the pusher gland *D* which is operated by the outside screw nut *E* above the bridge of the yoke.



CYCLONE BLOWOFF VALVE

The disk and holder are made of noncorrosive bronze. They have two faces and are regrindable, reversible and renewable. The plunger disk holder *G* is of bronze composition, and is milled to receive the lower collar on the stem. This holder *G*, fitting snugly in the bed, is given a centrifugal motion by the steam striking the spiral grooves cast around the sides, when opening and closing the valve. This motion of the plunger tends to keep the inside walls of the valve clean and does not give scale or sediment a chance to collect. In closing the valve, the plunger, in passing the inlet orifice, shuts off all the steam before the disk reaches the seat and the vacuum created by the rush of matter through the valve prevents the lodgment of scale or silt.

The seat *H* is made of white bronze and is reversible, regrindable and renewable. The expansion and contraction of this metal are said to coincide with that of the iron casting, assuring a tight joint of the seat and body at all times. Each valve is tested to 250 pounds hydraulic pressure.

The valve is manufactured by the William Powell Company, Cincinnati, O.

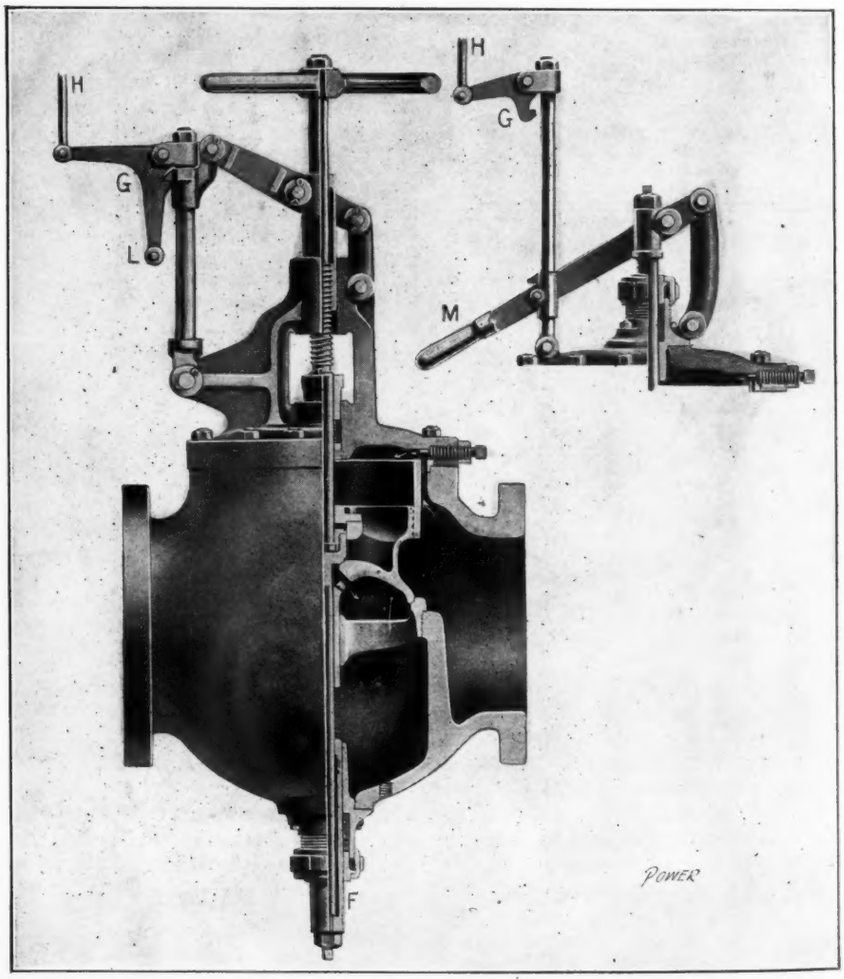
Schutte Balanced Trip and Trip Throttle Valves

These valves are intended as emergency shut-off or engine stop valves, and may be operated either by hand direct, with an electric solenoid and push button or automatically by the governor attached direct to the engine.

The trip valve is used in the steam-pipe connection to the engine and is operated independently of the throttle valve. The trip-throttle valve combines the features of a trip and throttle, thereby avoiding the necessity of two valves. It also has the advantage of being handled daily, thus assuring its being in operating condition; and will not, through lack of attention, or use from time to time, fail to operate when required.

The trip and throttle valve, shown herewith, when locked open, can be operated as a screw-spindle throttle valve. The screw is carried by a sliding trunnion that is connected by a lever and, when latched, forms a rigid connection with the yoke. The valve is then free to be operated by the handwheel and screw; should the valve be open or partially so, it may be instantly closed by tripping the latch *G*, either by a pull on the rod *H* or the handle *L*.

The balanced trip-valve locking device, shown at the right, is locked open by moving the handle lever until the catch on the same engages with the lever *G* that supports the upright bar. After the valve is open, steam pressure acts on the area of the piston *F*, shown at the bottom of the valve body, with a continuous downward force, which causes



THREE-TRIP DEVICE OF THE SCHUTTE BALANCE TRIP AND TRIP-THROTTLE VALVES

the valve to close as soon as the catch is released. A hand lever *M* is attached to the rod *H* and the same rod extended to any desired location will permit operating the valve promptly and without effort.

These valves are manufactured by Schütte & Koerting Company, Thompson and Twelfth streets, Philadelphia, Penn.

The Short Flexible Stuffing Box

The Short flexible stuffing box shown in Fig. 1 is packed ready for the gland. The spring cases on the outside are fitted with caps of a standard size. When used for high pressure, or ammonia, the caps can be removed and oil fed to the rods.

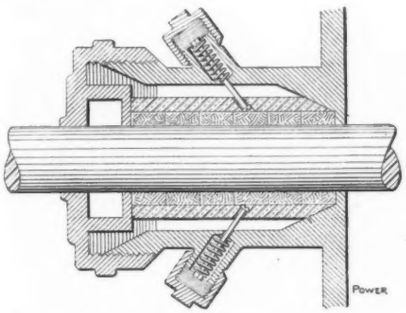


FIG. 2. SECTIONAL VIEW OF THE SHORT STUFFING BOX

Fig. 2 illustrates the box cut through the center and shows two of the four working bars. These bars are under the control of four master bars which are beveled at both ends and when the gland presses against them they slide on the 20-degree plane toward the center, taking four other bars together with the springs with them, leaving no opening or recess in which packing can catch. The position of the springs in relation to the bars is also shown. The bars are connected to the springs by means of a rod which is constantly pulling on them at an angle of 45 degrees. When it is necessary to repack, the gland is backed off and the springs pull the flexible parts back to place.

Fig. 3 shows an end view of the gland

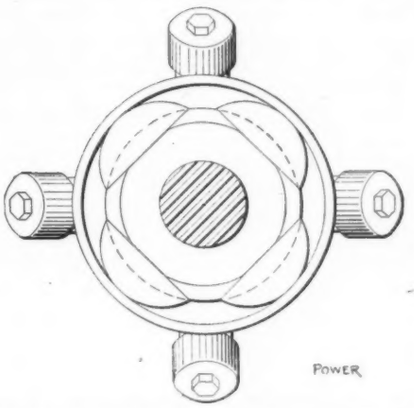


FIG. 3. END VIEW OF THE STUFFING BOX

and how it gets its flexibility. The master bars have a flat face against the packing and set; the bars to which the springs are attached have two flat sides that are at right angles with the packing

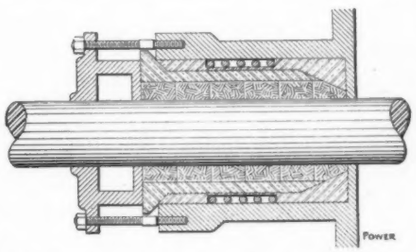


FIG. 4. DEVICE AS APPLIED TO ORDINARY STUFFING BOX

rings. The sides that come in contact with the packing are cut so as to form a circle. These bars come in contact with the master bars with their right-angle sides tapering down to a feather edge. This allows a movement from one extreme to the other, keeping a steam-tight joint.

The method of placing the flexible parts into an ordinary stuffing box when a part of the cylinder or steam chest, is shown in Fig. 4.

This device is manufactured by W. C. Short, 1756 Park avenue, Denver, Colo.

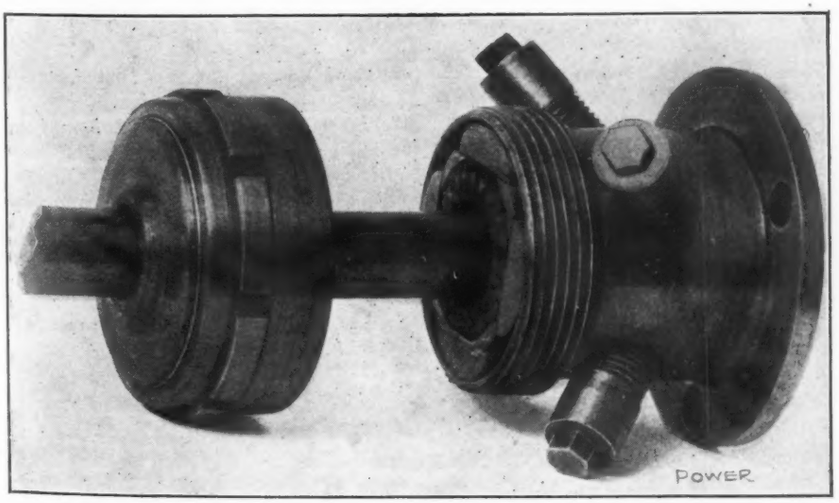


FIG. 1. STUFFING BOX AND PACKING

Boilermakers Convention at Omaha

Pleasing and elaborate exercises marked the opening of the fifth annual convention of the International Master Boiler Makers Association, held at Omaha, May 23, 24, 25 and 26. Mayor J. C. Dahlman delivered the principal address of welcome, after which other prominent commercial and railroad men of the city spoke briefly to the visitors. A number of the leading members of the association responded, thanking the citizens of Omaha for their cordial welcome, and they were heartily seconded by President A. N. Lucas, in his annual address.

As the meeting extended over four days, it was arranged to have business sessions only in the morning, leaving the members free in the afternoons to take advantage of the liberal entertainment provided by the convention committee. As the temperature hovered around 90 degrees during the stay in Omaha, this was found to be a welcome arrangement.

Reports of various committees occupied the greater portion of the business sessions, the subjects having to do largely with railroad work, in which the membership is interested. Among the subjects discussed were: "Standardization of Shop Tools and Equipment," "Pipe Flanges and Templets for Drilling Same," "Advantages and Disadvantages of Fire Brick Arches," "Methods of Producing Better Circulation in Boilers," "Use of the Oxyacetylene Process Welding," "Best Method for Caring for Flues," "Best Methods for Staying Front of Crown Sheet," and "Steel Versus Iron Flues."

The entertainment program included visits to the Union Pacific Shops, Stock Exchange and Cudahy Packing Company, as well as numerous automobile rides and special excursions about the city, winding up with a banquet at the Rome hotel, followed by a dance in the convention hall. In all, the meeting was one of the most successful ever held by the organization.

The New York State Association of the National Association of Stationary Engineers will hold its annual convention at Albany on June 9 and 10. The committee of arrangements anticipate an unusually successful meeting.

Iowa State N. A. S. E. Convention

Ottumwa was the scene of the eighth annual State convention of the National Association of Stationary Engineers of Iowa, the dates being May 25, 26 and 27. The opening exercises included invocation, by Rev. W. D. Spiker, and addresses by S. H. Harper, mayor of Ottumwa, and M. B. Hutchison, president of the Commercial Association. F. W. Raven, national secretary, responded on behalf of the National Association of Stationary Engineers, after which C. A. Orr addressed the meeting for the local entertainment committee. E. P. Gould, secretary of the Central States Exhibitors' Association closed the opening exercises, with a few remarks on the possibilities of coöperation between the engineer and the supply man.

An illustrated lecture on "Petroleum—Its Products and their Manufacture," was given by W. A. Converse, of the Dearborn Drug and Chemical Company, and H. H. Dewey, of the General Electric Company, delivered an interesting talk on "Alternating Current Machinery."

The social features were well arranged and ample in every particular and culminated in a banquet given at the Hotel Ballingall, with Mayor Harper as toastmaster. One hundred and twenty delegates, their wives and visitors, sat down to the tables and partook of the full course dinner provided, after which F. W. Raven spoke on "The Objects of this Association." E. J. Doolittle, of Sioux City, was then called upon for some remarks in regard to the benefits to be derived from a license law, while others were called upon for five-minute talks on subjects of special interest to the members of the association.

Sioux City was chosen as the place of next meeting, the officers for the ensuing year being elected as follows: D. A. Coulson, of Sioux City, president; A. E. Powell, of Burlington, vice-president; Abner Davis, of Cedar Rapids, secretary, and George H. Beebe, of Marshalltown, treasurer.

The following firms had exhibits at convention hall: American Steam Gauge and Valve Manufacturing Company, Boston; Anchor Packing Company, Chicago; George B. Carpenter Company, Chicago; Commercial Lubricating Company, Philadelphia; Crandall Packing Company, Palmyra, N. Y.; Dearborn Drug and Chemical Works, Chicago; Fisher Governor Company, Marshalltown, Ia.; Garlock Packing Company, Palmyra, N. Y.; Greene, Tweed & Co., New York; Hawk-Eye Compound Company, Chicago; Hills-McCanna Company, Chicago; Hulson Grate Company, Keokuk, Ia.; Jenkins Brothers, New York; H. W. Johns-Manville Company, Milwaukee; Lunkenheimer Company, Cincinnati; Lyons Boiler Works, De Pere, Wis.; McMaster-Carr Supply Company, Chicago; Murray Iron Works, Burlington, Ia.; *National Engineer*, Chicago; Osborne High-Pressure Joint and Valve Company, Chicago; Ottumwa Iron Works, Ottumwa, Ia.; Penn Oil and Supply Company, Oil City, Penn.; POWER, New York; *Practical Engineer*, Chicago; The S. C. Regulator Company, Fostoria, O.; Standard Oil Company, New York; Stoersel Oil Works, Ottumwa, Ia.; Trapp Pressure Control Company, Sioux City, Ia.; Under-Feed Stoker Company of America, Chicago, and Viscosity Oil Company, Chicago.

STATE CONVENTION GROUP AT OTTUMWA, IOWA

Special Charter for Museum of Safety

A special charter has just been granted to the American Museum of Safety by the legislature of the State of New York, thus putting it in the same class with the Metropolitan Museum of Art and the Museum of Natural History.

Among the trustees of the museum are E. H. Gary, Philip T. Dodge, James Speyer, Thomas Lynch, Arthur Williams, Edson S. Lott, Frederick L. Hoffman, George F. Kunz, Charles Kirchhoff, T. C. Martin, Charles A. Doremus, Louis L. Seaman, Frederick R. Hutton, William H. Tolman.

The exhibits at the museum include protective devices for the safeguarding of human life in almost every field of labor, from the turning of a grindstone to the moving of a freight train. The collections are of interest even to the ordinary observer, and of great value to the manufacturer, for, at present, annually, in the United States, over 500,000 men are wiped out from the ranks of the wage earners.

A Correction

On page 762 of POWER for May 16, bottom of third column, the 90-inch boilers under discussion in Mr. Dean's article are credited with having tubes 18 feet long. The tubes are 20 feet long and this figure should have been given in the table.

N. A. S. E. to Meet at Cincinnati

The Cincinnati members are planning to make the convention of the National Association of Stationary Engineers, to be held in that city in September next, the best in the history of the organization. The headquarters' hotel will be the Sinton and the meetings will be held at the Music Hall, in one wing of which the Exhibitors' Association will have its display. A lunch will be served in the building to preclude the necessity of going back and forth between the hall and the hotel at noontime.

The program as tentatively laid out is as follows:

On Monday evening a reception at the Sinton, followed by dancing.

On Tuesday the formal opening of the convention with addresses by the governor and mayor.

On Wednesday the visitors will be the guests of the Lunkenheimer Company who will take them to the Government dam at Fernbank on the steamer "Island Queen" and from there to Coney Island where a barbecue will be held.

On Tuesday and Thursday evenings there will be entertainments at the Music Hall, one under the auspices of the local committee and one under the auspices of the Exhibitors' Association, and on Friday evening a ball, also at the Music Hall.

Liberal provision has been made for the entertainment of the ladies while the convention is in session.

PERSONAL

Frank E. Marcy, formerly with the Allis-Chalmers Company, has been appointed manager of the branch house of the Mine and Smelter Supply Company in Salt Lake City, Utah.

Messrs. Lucke and Ophuls have formed a partnership and have opened an office at 30 Church street, New York City, for the practice of engineering connected with the installation, operation and maintenance of breweries, cold-storage and ice-making plants and other manufacturing establishments using mechanical refrigeration.

Joseph L. Hern, formerly superintendent of heating and ventilation with the school-house commission, Boston, and Francis J. Furlong, formerly superintendent of construction with the Cleghorn Company, Bradlee & Chatman and J. P. Dwyer, have formed a partnership under the firm name of Hern, Furlong Company, engineers and contractors for power, heating and ventilation, 149 Pearl street, Boston, Mass.

C. E. Burgoon and H. W. Matthews have formed the Burgoon-Matthews Electric Company with headquarters at Atlanta, Ga. The company will conduct a general wholesale and retail electrical-supply business and will represent a number of manufacturers of power-station equipment. Mr. Burgoon was formerly chief engineer of the Federal building, Chicago; and Mr. Matthews was associated with the Westinghouse Electric and Manufacturing Company as an electrical engineer.

Fay Woodmansee, C. J. Davidson and E. O. Sessions announce their association under the firm name of Woodmansee, Davidson & Sessions, Incorporated, 1048 First National Bank building, Chicago.

Fay Woodmansee for nine years has been associated with Sargent & Lundy, as electrical engineer. C. J. Davidson for thirteen years has been in charge of the power-plant department and steam-heating department of the Milwaukee Electric Railway and Light Company, including during this period consulting work in St. Louis and other cities where the North American Company were interested. E. O. Sessions for twenty-three years has been associated with the General Electric Company in its engineering and sales departments.

It is the purpose of this firm to act in a consulting and supervising capacity in all branches of mechanical and electrical engineering, including designs and specifications for power plants, substations, hydroelectric equipments, transmission lines, electrical distribution systems and mechanical refrigeration. Reports on properties and appraisals will be made and particular attention will also be given to district-heating systems.

NEW PUBLICATIONS

THE "PRACTICAL ENGINEER" ELECTRICAL POCKETBOOK AND DIARY. Published by the Technical Publishing Company, London, 1911. Five hundred and sixty-seven pages, 3½x5½ inches; numerous illustrations and tables. Price, cloth, 1s.; leather, 1s. 6d.

A handy little book containing much valuable data and notes on current practice in electrical engineering, as well as the Board of Trade rules regarding the installation of electrical equipment. Several sections have been revised in this edition to keep pace with the developments in practice during the past twelve months.

MACHINE DRAWING. By Gardner C. Anthony. Published by D. C. Heath & Co., Boston, 1910. Cloth; 104 pages; 7¼x5¾ inches; many illustrations; 10 tables. Price, $1.50.

This book is not for beginners but rather for those who are familiar with descriptive geometry. It contains considerable sound and good matter on the preparation of shop drawings. The tables are of practical value and enhance the worth of the book to the man in the drafting room. Some inconsistency is shown where the subject of lettering is treated. This, however, is unimportant. The book can be conscientiously recommended to all who would become efficient in the principles of this subject.

NOTES ON MECHANICAL DRAWING. By Horace P. Fry. Published by the University of Pennsylvania, 1910. Cloth; 57 pages, 6x9 inches; 51 illustrations.

Although this booklet is but an introduction to mechanical drawing, it should be correct and thorough for that very reason. Above all, it should not be irrational in dealing with points which must be left largely with judgment, even though the book is intended for specific use. The author claims to pattern after the Reinhardt system of lettering. This is slightly incorrect as the lettering displayed throughout is anything but after the Reinhardt system. Briefly, the book needs more careful revision than it has so far received.

ENGINEERING CHEMISTRY. By Thomas B. Stillman. Published by the Chemical Publishing Company, Easton, Penn., 1910. Cloth; 744 pages, 6x9 inches; 174 illustrations, numerous tables. Price, $5 net.

This is the fourth edition of Professor Stillman's manual dealing with chemistry as applied to the mechanic arts, and much of the text of the earlier editions has been amplified and brought uptodate. The subjects covered are, coal analysis and specifications, feed-water heaters, economizers, flue-gas analysis, calorimetry, the manufacture of water gas, burning of natural gas under boilers, blast-furnace gas applied to internal-combustion motors, liquid fuel, lubricating oils, analysis of iron and steel, cement, asphalt, etc.

The book is not in any sense theoretical but deals, for the most part, with commercial processes, and as such should prove a valuable reference book for any engineer.

LOGARITHMS FOR BEGINNERS. By Charles N. Pickworth. Published by D. Van Nostrand Company, New York, 1910. Cloth; 43 pages; 4¼x7¼ inches; three tables. Price, $1, net.

If the title of this book were "Logarithms," beginners would not have excuse for finding fault. As is intimated by the author in the preface, the increasing use of exponential and other complex formulas in the calculations involved in the later developments of thermodynamics and of the electrical, physical and chemical sciences, makes it highly important to have a thorough understanding of the logarithmic methods of calculation. Ability to make use of logarithms, however, does not necessitate great mathematical preparation. And it is because of this fact that we see the possibility of the beginner making complaint of the author's method of treating the

subject. It is our opinion that to be benefited by this book, it is first necessary to have a considerable understanding of algebra; more of an understanding, perhaps, than would be needed to make use of logarithms.

Granting that the user has the necessary familiarity with algebra, this book fulfils its purpose admirably. Interspersed throughout are illustrative problems and the answers thereto. These add greatly to the worth of the book.

APPLIED THERMODYNAMICS FOR ENGINEERS. By William D. Ennis. Published by D. Van Nostrand Company, New York, 1910. Cloth; 450 pages, 6½x9 inches; 316 illustrations. Price, $4.50.

Nothing could better proclaim Professor Ennis' natural genius for the systematic exposition of scientific principles than this work. It is at once the most thorough, most lucid and simplest treatise on the subject that the reviewer has seen. There are numerous minor defects, of course; the days of miracles are long past. On page 7, for example, it would have been advisable to explain that the symbol for heat received is positive and that for heat rejected negative, in the general formula for heat transfer; on page 19, air is referred to as a gas and gases are said to "follow" Boyle's law; on page 20, Charles is properly given credit with Gay-Lussac for the law:

$$\frac{PV}{T} = constant$$

but nothing is said of how he derived it; on page 33 and elsewhere, specific heats are represented "in proper units" by the unusual symbols k and l and the letter R is given both the correct value of 53.36 (for air) and the inconsistent one of 53.36 ÷ 778, in conformity with the statements on page 37 that "no attention is paid to the ratio 778 as affecting the numerical values of constants in formulas involving both heat and work" and "the student should discern whether heat units or foot-pounds are intended." This is slovenly and cannot fail to blunt the student's regard for accuracy; it is the most serious lapse in the book.

It will be apparent from the foregoing that the flaws are not glaring; nearly all of them, in fact, are negligible in importance.

The book is very broad in scope. All known cycles are described and thoroughly analyzed (and the Rankine and Clausius cycles are not confused as is usually done in textbooks); the thermodynamics of all heat-converting engines, both positive and negative, are treated, and the relations between the abstract science and the actual conversion machines are very clearly presented. The book differs from most textbooks in being both an excellent tool for the college professor and a highly satisfactory reference book for practising engineers whose catholicity of ready knowledge has been impaired by specialization.

STEAM TURBINES. By Joseph Wickham Roe, M. E. Published by McGraw-Hill Book Company, New York, 1911. Cloth; 143 pages; illustrated. Price, $2.

The author, who is assistant professor of mechanical engineering at the Sheffield Scientific School, Yale University, has produced an excellent little work adapted to the needs of the engineer who wishes to inform himself on the principles and general design of turbines as well as for a textbook for a short course upon the subject. He who has wondered what all the velocity diagrams and velocity-pressure schemes so often published in connection with turbine discussions mean will find them explained here in all simplicity, requiring the possession of only a little elementary trigonometry for their comprehension. Each division of the subject is followed by a list of practical examples the solution of which requires the application of the principles which have been explained and the use of the formulas deduced, and a list of references to other works for those who wish to pursue that phase of the subject further.

The first chapter is devoted to the explanation of the energy in a jet. The consideration of the velocity derivable could have been improved by giving some of the simple formulas for the energy derivable from a pound of steam, which are precise within the limits of precision of the steam tables which are necessary for the working of the approximate formula which he gives.

The second chapter deals with the utilization of the kinetic energy in steam and shows by means of the velocity diagram how this energy is absorbed by the wheel. The method of finding the trajectory of the steam is also explained. About 30 pages are then devoted to "Calculations of Turbine Blading."

Under the title of "Mechanical Problems," the author takes up centrifugal strains but says little or nothing of critical speeds and balancing. Bearings and governing are treated in this section.

Chapter V is hardly a "Comparison of Types," but a description of the Curtis vertical, Terry, Kerr, Rateau, Zoelly and Allis-Chalmers machines, and of the Rateau regenerator and mixed-flow turbine.

The effect of superheat and vacuum, but not of pressure, is considered in the next chapter, which contains also a description of the Parsons augmentor. The concluding chapter deals with "The Position and Field of the Steam Turbine," giving the formula for potential efficiency and tables of test results and potential efficiencies of engines and turbines. The advantages and disadvantages of the turbine for various lines of service are considered and the fact pointed out that up to February, 1911, the sales of the three foremost manufacturers of large turbines in the United States had aggregated 4,100,000 kilowatts. Scarcely a dozen of the machines are over a dozen years old and the majority have been built within the last five years. The volume concludes with a heat-entropy chart and a summary of the bibliography of the subject.

BOOKS RECEIVED

GOOD ENGINEERING LITERATURE. By Harwood Frost. Chicago Book Company, Chicago, Ill. Cloth; 422 pages, 5x7½ inches; indexed. Price, $1.

POWER. By Charles E. Lucke, PH. D. The Columbia University Press, New York. Cloth; 316 pages, 5¼x7¾ inches; 223 illustrations; indexed. Price, $2.

MONOPLANES AND BIPLANES. By Grover Cleveland Loening. Munn & Co., New York. Cloth; 331 pages, 5½x8 inches; 278 illustrations; indexed. Price, $2.50.

VACUUM CLEANING. By Thomas D. Perry. The American School Board Journal, Milwaukee, Wis. Paper cover; 44 pages, 4½x6¼ inches; illustrated. Price, 15 cents.

STEAM TURBINES. By Joseph W. Roe. McGraw-Hill Book Company, New York. Cloth; 136 pages, 6x9 inches; 77 illustrations; tables and plate; indexed. Price, $2.

SEVEN FOLLIES OF SCIENCE. By John Phin. D. Van Nostrand Company, New York. Cloth; 231 pages, 5x7½ inches; second edition; 34 illustrations; indexed. Price, $1.25.

HYDRO-ELECTRIC PRACTICE. By H. A. E. C. von Schon. J. B. Lippincott Company, Philadelphia, Penn. Second edition; cloth; 383 pages, 6¾x9½ inches; 140 illustrations. Price, $6.

STORAGE BATTERY ENGINEERING. By Lamar Lyndon. McGraw-Hill Book Company, New York. Third edition; cloth; 601 pages, 5¾x9 inches; 298 illustrations; tables; indexed. Price, $4.

ELECTRIC CRANE CONSTRUCTION. By Claude W. Hill. J. B. Lippincott Company, Philadelphia, Penn. Cloth; 313 pages, 6x9 inches; 366 illustrations; 23 tables; plates; indexed. Price, $8.

A TREATISE ON TRANSFORMERS. By Hermann Bohle and David Robertson. J. B. Lippincott Company, Philadelphia, Penn. Cloth; 356 pages, 6x9 inches; 332 illustrations; 18 plates; tables; indexed. Price, $7.50.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

DOES advertising pay the buyer? Read this:

NEW YORK, May 10, 1911.

Gentlemen:

I have read your articles on the effect of advertising from the consumers' standpoint, with considerable interest.

Having had some fifteen years' experience in utilizing advertising in co-operation with salesmen (also on a strictly mail order basis) I think possibly this letter may make clear a few facts that some buyers have perhaps not heard of.

I am going to give you a concrete example of advertising's value to the consumer—when the advertising is entrusted to educated and developed men. A moment's reflection will show the reader that the principle here involved obtains in EVERY meritorious advertised product, provided, only, the advertising is efficiently done.

This is the instance referred to:

A concern here in New York City perfected a small labor-saving machine. The man who purchased one could not save enough money by its employment to pay for it in twenty years by the work done. In brief, its sole value lay in the quicker service that the user of this machine could extend his customers.

Like many another concern, they followed the line of least resistance, viz.: they wanted other people to do for them the selling work which they should do for themselves. So they tried to interest jobbers. The jobbers catalogued them. But nothing happened—that is, comparatively nothing. The point is that this machine was a specialty. Prospective customers had negative ideas about it. It was too hard work for the jobber's salesmen to "bring them across." Effect: stagnation.

Now, this machine was really needed among the trade for which it was intended. It had the basic merit of saving delays for the customer. Thus, though the enterprise was really a failure, it was obvious that the proposition of itself, fundamentally, was all right.

The problem on the face of it was to reduce the cost of selling (jobbers were getting 40%) by increasing the volume of sales per month and cutting out the jobber. Regardless of whether or not goods are sold through jobbers or sold direct, it is axiomatic in the economics of selling that the cost of doing business depends almost entirely upon the time it takes to turn over a given volume of marketable product.

Turn over enough product in a given amount of time, and though the profit be only ½ of 1% a man can amass a fortune, provided only his market is broad enough.

To make a long story short, in this particular instance advertising, both in trade papers and by following up through the mails, was resorted to.

The net result at the end of the first year of this aggressive effort was a reduction in the selling expense from 50% to 10%. At the end of three years the article was well known and in wide use throughout the United States, and the salesmen all had a better income. Further, by the end of the second year jobbers were glad to handle the machine at a discount of 10%, and they really did sell them, if it may be called that, for the market was created. In reality, they were taking orders. The advertising had done the selling before the jobbers' salesmen broached the subject to the prospect.

Did the consumer benefit? He certainly did. Because this concern was conscientious enough and far seeing enough to put back into their product half of the saving in selling expense that this campaign effected. Actually, from the standpoint of durability, reliable service and appearance, the machine was worth twice to the consumer what it had been previous to the campaign.

There is a point here for consumers everywhere to ponder over, which is simply, that the manufacturer of an advertised product must constantly put more value into it, because the only hope of the maker of an unadvertised product to compete with him is to make HIS product better. Thus, a natural law operates in the interest of the consumer—Emerson would call it Compensation.

And note this: the manufacturer of an advertised product who does his advertising properly can put more value into his product than his competitor, because advertising, when efficiently done, does reduce selling cost and does enable the manufacturer to actually give his purchasers a NEW STANDARD of excellence in quality and service.

Very truly yours,

E. H. White.

NELSON GOODYEAR, Inc.

* * *

Judging by the evidence submitted it will pay *you* to read the ads and buy advertised goods.

BUSINESS ITEMS

The United States naval experimental station at Annapolis has requested the George M. Newhall Engineering Company, of Philadelphia, Penn., to furnish its high- and low-pressure Vance steam traps for a series of tests.

On June 1 the Sprague Electric Company was merged with the General Electric Company, of Schenectady, N. Y. Its business will be conducted under the name of the Sprague Electric Works of General Electric Company. The manufacture and sale of the lines of apparatus and supplies heretofore exploited by the Sprague Electric Company will be continued by the Sprague Electric Works of General Electric Company under the same organization, with D. C. Durland in responsible charge as general manager. The offices of the Sprague Electric Works will be continued as heretofore, the main offices being at 527-531 West Thirty-fourth street, New York City.

The Kerr Turbine Company, Wellsville, N. Y., has just been reorganized and $125,000 new capital added. The stock interests of the company are now controlled by F. E. Merrill, of Hornell, N. Y., and P. B. Hanks, of Wellsville, who, as trustees, have directed the affairs of this company for the past two and a half years. Mr. Kerr is no longer with the company, his position as chief engineer now being filled by J. L. Moore, formerly a designer with the Westinghouse Electric and Manufacturing Company, and later in the engineering department of the Santa Fe railroad. The present plant will be materially enlarged and a new machine shop is already in course of erection. It is the intention of the new company to incorporate into the Kerr turbine, design changes which are based upon two years' experiments and which will improve the steam economy on all sizes by from 15 to 20 per cent.

NEW EQUIPMENT

Waterproof, La., will construct waterworks.

Carlyle, Sask., will install new waterworks pumping plant.

Prince Rupert, B. C., will spend $500,000 for waterworks.

North Haven, Me., proposes installing a new water system.

Braintree, Mass., will make improvements in its water system.

The Portland (Me.) Gas Light Company will build an addition.

Cornelia, Ga., voted $5000 bonds for waterworks and sewer system.

The London (Ont.) Gas Power Company will build additions to its plant.

Shelburne Falls, Mass., will spend $75,000 on improving its water system.

Morgan Hill, Cal., is planning a bond issue for the construction of waterworks.

Hyde Park, Mass., will extend its water system and build a pumping station.

Queen City, Mo., will construct an electric-light plant. W. M. Saxbury, mayor.

The plant of the Indio (Cal.) Ice and Cold Storage Company was destroyed by fire.

Houma, La., will spend $40,000 to construct waterworks. G. G. Gill, city clerk.

The village of Bloomingdale, N. Y., will install a waterworks system to cost $15,000.

The S. A. Woods Machine Company, South Boston, Mass., is figuring on a new power house.

Rockville Center, L. I., N. Y., will vote on the appropriation of $17,000 for a new power house.

The Prince Rupert Meat Company, Vancouver, B. C., will build a new cold-storage plant.

The North Star Mines Company, Grass Valley, Cal., is planning to build a new power plant.

Orland, Cal., has voted bonds for $50,000 for the installation of waterworks and sewer system.

The Rollins Engine Company, Nashua, N. H., is considering the installation of a new power plant.

The International Rubber Company, West Barrington, R. I., will install a 200-horsepower engine.

The North Attleboro (Mass.) Electric Light Company is in the market for a 300-horsepower engine.

Schwanbeck Brothers, Detroit, Mich., will build a new show-case factory, including separate power house.

The Murphy Water, Ice and Light Company, Needles, Cal., is contemplating improvements to its plant.

The city council, Seattle, Wash., has authorized an expenditure of $75,000 for a new power plant on Lake Union.

The Cutting Packing Company, Stockton, Cal., is having plans prepared for a new fruit-packing plant at Ocampo.

The American Agricultural Chemical Company will build a new power house at 114 Fleming street, Buffalo, N. Y.

Mexico, N. Y., is having plans prepared by W. G. Stone, Mann building, Utica, N., Y., for waterworks to cost $50,000.

The Fairview (S. D.) Milling Company is to erect a hydroelectric plant on the Big Sioux river to cost about $116,000.

The Philadelphia Electric Company has purchased site at Sixth street and Germantown venue for a new power plant.

The Nez Perce & Idaho Railway, Nez Perce, Ida., is planning to increase the capacity of its power plant near Greer.

Swift & Co., of Chicago, have awarded contract for the erection of a building at Pensacola, Fla. Will install cold-storage plant.

The Newberg (Ore.) Electric Company will make improvements in its plant. New and heavier power-plant equipment will be installed.

The county commissioners of Bristol county will install two horizontal return-tubular boilers at the New Bedford (Mass.) House of Correction.

The Redondo Beach (Cal.) Ice and Cold Storage Company, recently incorporated, is having plans prepared for an ice and refrigerating plant.

The San Joaquin Light and Power Company, of Fresno and Los Angeles, Cal., will build new substations at Maricopa, Moran, McKittrick, Famosa.

The Canton (Ohio) Electric Company will build an addition to its power plant, and it is said, is planning other improvements to to cost $300,000.

The Orlando (Fla.) Water and Light Company will install a 2,000,000-gallon pump, 500-kilowatt generator and engine and make other improvements.

The Nevada-California Power Company, Goldfield, Nev., is planning to build a new power plant. Is rebuilding plant at Jordan, Cal., recently damaged.

Plans are being prepared for an eight-story building to be erected by John Martin, San Francisco, Cal., for which power-plant equipment will be required.

Eufaula, Ala., will construct an electric-light plant. Bids will be received until June 7. W. L. Upton Company, Brown-Marx building, Birmingham, engineer.

Power-plant equipment will be required for the new hotel to be erected by the Kern County Land Company, at Bakersfield, Cal. Refrigerating plant will also be installed.

Power-plant equipment will be needed for a new $500,000 building to be erected for the Washington State Art Association, Seattle, Wash. Kingsley & Eastman, architects.

The Cleveland (Ohio) Painesville & Eastern Railroad Company will increase the capacity of its power station at Painesville and build substations at Willoughby and Nottingham.

The Deane Steam Pump Company, Holyoke, Mass., will be in the market for new power-plant equipment of about 450 kilowatts capacity. Will consider oil, gas or steam plants.

Proposals will be received until 11 a.m., June 9, at the quartermaster's office, Twenty-sixth street and Gray's Ferry road, Philadelphia, Penn., for one 200-horsepower water-tube boiler.

The Rubin Electric Power and Lumber Company, Chelan, Wash., has been incorporated with $500,000 capital by Chas. Rubin and Wm. H. Schokel. Is planning for extensive operations.

The Colorado State College, at Fort Collins, Colo., is about to put in a central heating and lighting plant on the campus to cost about $75,000. Prof. J. W. Lawrence, of the college, is the engineer.

Proposals will be received at the Army building, Whitehall street, New York, until 3 p.m., June 15, for installing six pumps and accessories, at Fort Mills, P. I. M. Gray Zalinski, depot quartermaster.

The State engineer, Sacramento, Cal., is preparing plans for a gas-generation and electric power plant, at the Southern California State Hospital, at Patton; $55,000 has been appropriated by the legislature.

H. L. Gilman, engineer, Chestnut Hill, Boston, Mass., is preparing plans for a power plant for the American Buildings Trust, at South Boston. Will be in the market for engines, generators, boilers, pumps.

Proposals will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until 11 a.m., May 27, for air, steam, water and electric meters. Specifications can be had of R. C. Hollyday, chief of bureau.

NEW CATALOGS

John B. Perkins Company, Boston, Mass. Catalog. Bradford valves. Illustrated, 20 pages, 6x9 inches.

Buffalo Forge Company, Buffalo, N. Y. Booklet. Spray nozzles and strainers. Illustrated, 16 pages, 4½x8 inches.

Allis-Chalmers Company, Milwaukee, Wis. Bulletin No. 1624. Centrifugal pumps. Illustrated, 20 pages, 8x10½ inches.

Elliott Company, 6910 Susquehanna street, Pittsburg, Penn. Bulletin No. 150. Strainers. Illustrated, 24 pages, 7x10 inches.

Mesta Machine Company, Pittsburg, Penn. Catalog. Horizontal, double-acting four-cycle gas engine. Illustrated, 16 pages, 6x9 inches.

The Climax Smoke Preventer Company, Boston, Mass. Catalog. Climax smoke preventer. Illustrated, 20 pages, 6x9 inches.

Kelly Foundry and Machine Company, Goshen, Ind. Catalog B. Rocking, dumping and stationary grates. Illustrated, 24 pages, 6x9 inches.

Manzel Brothers Company, Buffalo, N. Y. Catalog No. 15. Manzel automatic force- and sight-feed oil pump, class HA. Illustrated, 3½x6 inches.

The Wm. Powell Company, Cincinnati, Ohio. Catalog No. 10. Valves, lubricators, cocks, grease cups, etc. Illustrated, 288 pages, 5½x8 inches.

The Oster Manufacturing Company, Cleveland, Ohio. Catalog No. 26. Die stocks, stocks and dies, pipe-threading machines. Illustrated, 64 pages, 6x9 inches.

Chapman Valve Manufacturing Company, Indian Orchard, Mass. Catalog No. 30. Valves, fire hydrants, indicator posts, sluice gates, etc. Illustrated, 174 pages, 6x9 inches.

George M. Newhall Engineering Company, 136-138 South Fourth street, Philadelphia, Penn. Engineers' Reference Book and Vance steam trap catalog. Illustrated, 64 pages, 4½x7½ inches.

The Strong, Carlisle & Hammond Company, 326-344 Frankfort avenue, Cleveland, Ohio. Catalog No. 14. Steam traps, pump governor, engine stop, etc. Illustrated, 60 pages, 6x9 inches.

Best Manufacturing Company, Pittsburg, Penn. Booklet No. 101. Standard tables, valves, fittings, flanges, pipe, bends, etc. Illustrated, 4x6½ inches. Price List No. 102. Flanged fittings and flanges. 18 pages, 3½x6 inches.

Central Station Steam Company, Detroit, Mich. Catalog No. 6. Condensation meters, traps and screens. Illustrated, 16 pages, 6x9 inches. Catalog No. 7. Expansion joints, anchor crosses, line anchors, etc. Illustrated, 16 pages, 6x9 inches.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEERS to solicit orders for the Rolin patent adjustable grate bar. Apply Standard Grate Co., Heed Bldg., Philadelphia, Penn.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

WANTED—Competent high pressure boiler salesman; will give the right man an opportunity of investing in a business established for forty years. Address Box 444, POWER.

SALESMAN calling at power plants to handle as a side line superior packing for steam, different from the rest and better. Nugget Packing Co., 185 Summer St., Boston, Mass.

WANTED—First class firemen, 12-hour shift, 6 days, $70 or $75 per month with premiums on coal economy; must be capable men; we have no place for coal heavers. Box 448, POWER.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

POSITION OPEN—Water wheel chief engineer; thoroughly competent designer and constructor to take full charge of latest up to date Francis turbine wheels and governors; applicant must have extended experience; give full particulars. Box 441, POWER.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

POSITION WANTED by a competent suction gas man as operator, own repairing; extensive experience on single and multiple cylinder plants; references furnished. Box 447, POWER.

TECHNICAL MAN, 34, married, 13 years' experience, power, light, telephone, construction and operation, want connection as electrical engineer or superintendent, light or power plant; good business ability; prefer West or South; would consider foreign country. Box 433, POWER.

GAS ENGINEER to take charge of producer gas engine plants, familiar with the erecting and operating of large horizontal and vertical gas engines; suction and pressure producers; low and high grade fuel; indicating and fuel analyses; mechanic and machinist; now in charge of 2000 horsepower plant in Mexico; age 37; willing to go to any place. Box 440, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

PATENTABLE IDEAS WANTED—Manufacturers want Owen patents. Send for three free books. R. B. Owen, 43 Owen Bldg., Washington, D. C.

PATENTS—Herbert Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make a free search and report if patent can be had and the exact cost.

The Vulcan Soot Cleaner offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

ENGINEERS AND FIREMEN—Send 10 cents in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Avenue, St. Louis, Mo.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

YOUR SALES AGENCY WANTED—Experienced mechanical and electrical sales-engineer wants eastern Pennsylvania agency; boilers, engines, generators, pumps, blowers, heating, steam or electric specialties; intimate acquaintance with architects, engineers, contractors, etc.; 16 years in territory. Box 385, Care E. C. Rahme, 38 N. Broad St., Philadelphia, Pa.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—One Cooper Corliss engine, 14—24x42 cross compound; in good order; now running; can be seen any day. John Boyle Co., Jersey City, N. J.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Jones underfeed stoker complete, with exception of furnace front, in first class condition; have no further use for it; will sell reasonably. Address "Michaels," Stern & Co., Rochester, N. Y.

FOR SALE—For immediate delivery, two Cooper Corliss engines, direct connected to Westinghouse direct-current, 125-volt generators, 100 r.p.m., sizes 100 to 200 kilowatts; also one Westinghouse vertical direct connected unit 25 kilowatt capacity, 125 volts, direct current. Box 449, POWER.

FOR SALE—One compound Reynolds Corliss engine, high pressure cylinder 32 inches, low pressure 60 inches, stroke 60, 1200 horsepower at 100 pounds pressure, 70 revolutions per minute, flywheel diameter 20 feet, face 56 inches, built in sections; shaft length 16 feet diameter in wheel 16 inches, single eccentric. Box 434, POWER.

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General Electric Co.	80
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Goulds Mfg. Co.	126
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Griscom-Spencer Co.	118
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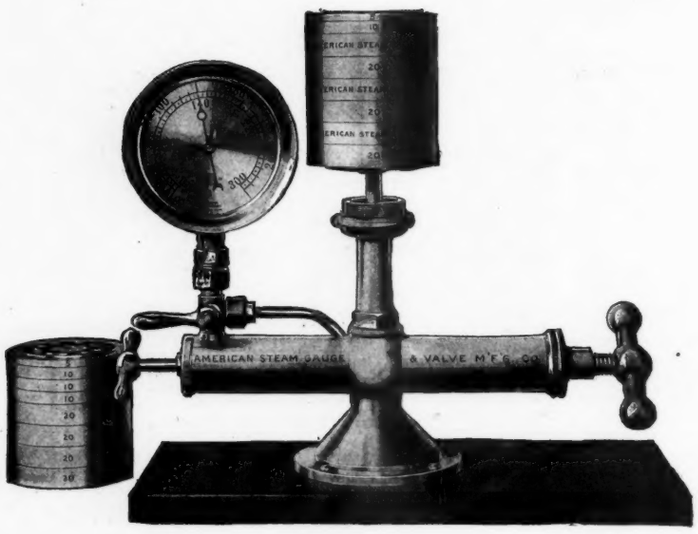

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